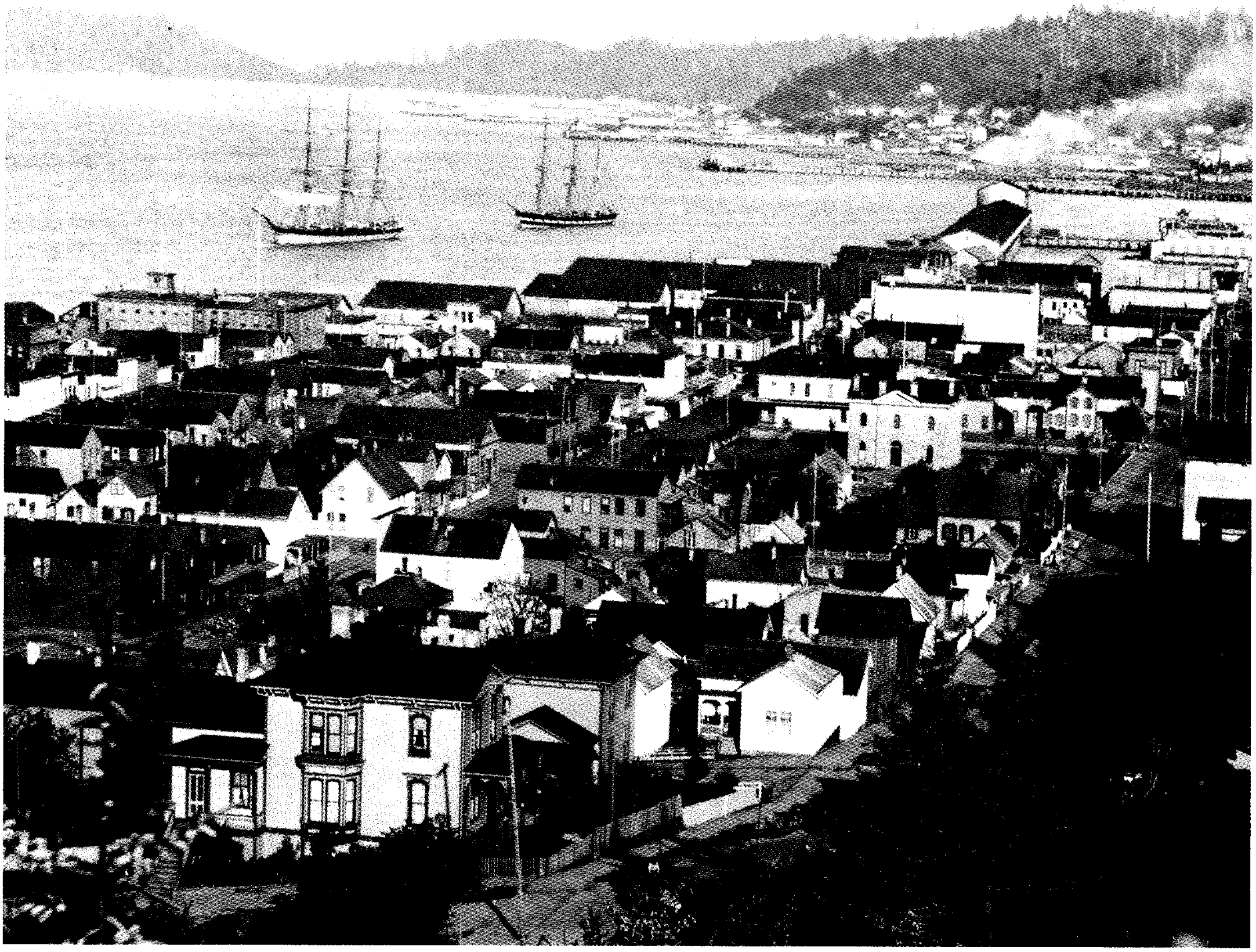


The harbor of Astoria, circa 1880.

Chapter 5 Navigation and Fortification Work on the Columbia, 1890 to 1920

Jetty at Mouth of the Columbia

In the three years during which work on the Columbia River jetty got underway, much activity occurred elsewhere in the district. Private interests constructed the first large pier and wharf installations in Portland after Captain Powell had selected a harbor line in 1882.[1] Captain Powell installed the first permanent and continuous river-gauging operation at Astoria, and data obtained from the self-registering instrument became available to the public. Additional gauges were placed on the Columbia and Willamette Rivers for the next 15 years, and coordinated information was distributed daily to interested people.

Between 1879 and 1882, Captain Powell performed a thorough survey of the site for the canal around Celilo Falls near The Dalles. This was accompanied by a rough plan proposing river improvements and Celilo Canal together with a cost estimate. The proposed canal dimensions were the same as those for the Cascades Canal and estimated construction time was 11 years. Another survey of Nehalem Bay led to a recommendation that no improvements be under taken at that time. Dredging operations and other improvements continued along the Willamette and Columbia where necessary, including the removal of several thousand trees from the banks of the upper Willamette. Powell also employed a novel method of sluicing the St. Helens Bar. When scraping proved ineffective in 1882, he convinced a local shipping company to loan him a propeller steamship to cut the channel. The ship was anchored above the bar and the stern weighted and moved from side to side by the rudder over a width of 100 feet. The current generated by the propeller improved the depth over the bar from 12.5 to 19.5 feet for a width of 180 feet and a distance of 1200 feet. Captain Powell annually used this temporary means to keep the St. Helens Bar open until

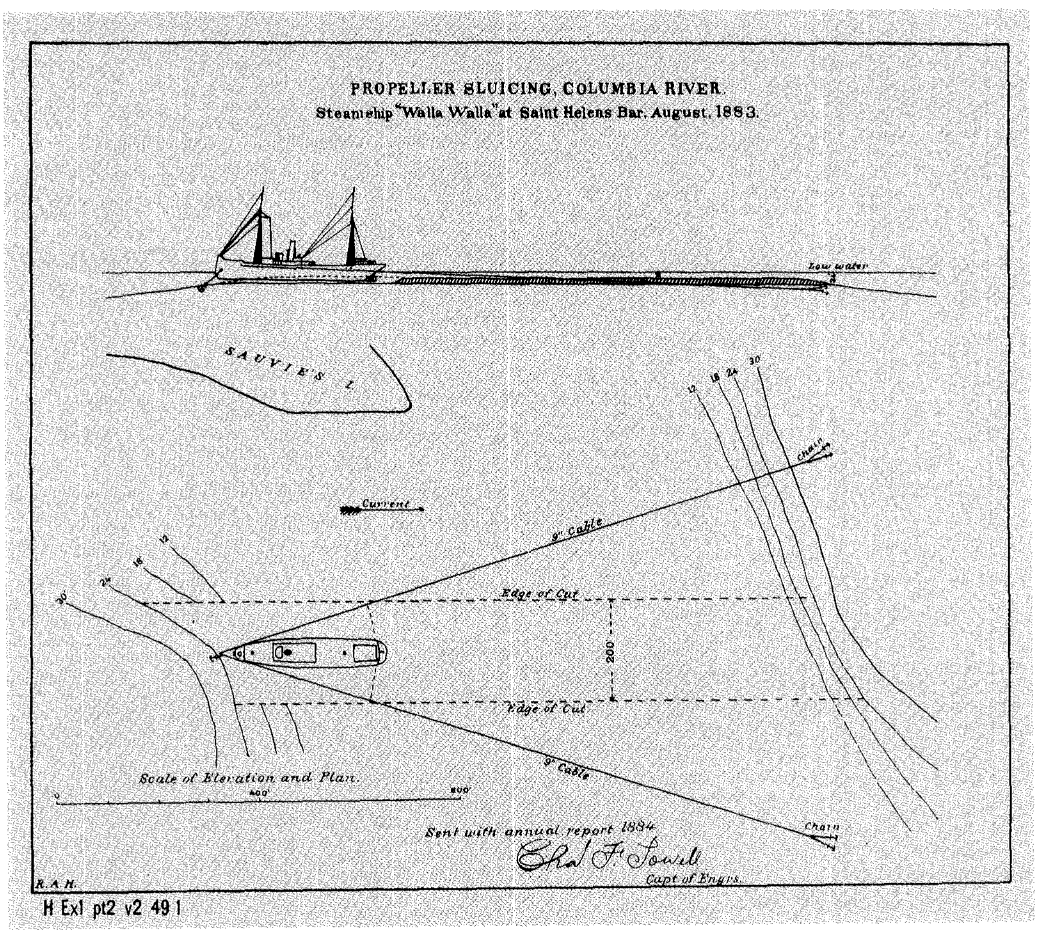


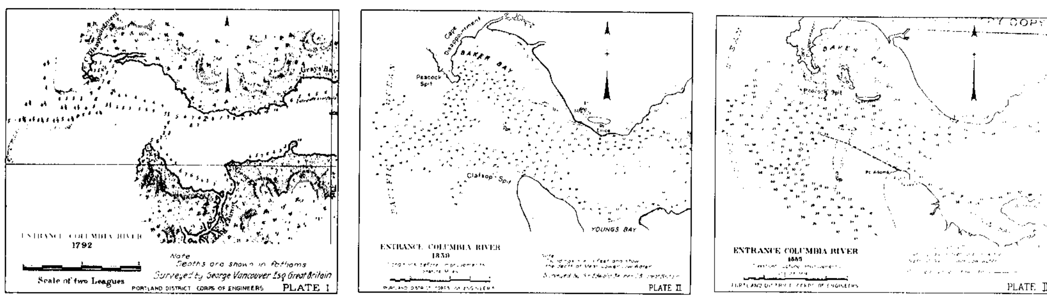
Diagram of propeller sluicing

the permanent improvements were completed at that location. At the Cascades Canal, work progressed under Lieutenants Philip Price and Willard Young, resident engineers.[2]

In 1882, Congress, responding to the strong support for improvements voiced by those living along the Columbia, ordered the Board of Engineers to reconvene and draw up a permanent plan to improve the mouth of the river. In that same year, Captain Powell reported to the Chief of Engineers that the ship channel had shoaled from twenty to nineteen feet at low water, diverting vessels elsewhere and causing others to leave port with less-than-capacity loads. The resulting losses caused "much uneasiness in the shipping interest of the Columbia River."[3]

The "uneasiness" was most forcefully expressed to Powell by the Astoria Chamber of Commerce. This body not only complained that the shoal resulted in financial losses but that it also gave an advantage to foreign shipping over American vessels. The Chamber explained that British iron vessels drawing 20 to 22 feet carried more cargo than wooden American ships which drew 23 to 26 feet of water. Since the market for Pacific Northwest wheat lay overseas, "British vessels carry our produce to Great Britain and Europe, in much larger proportions than is done from San Francisco or deeper ports."[4]

The Board handed down a plan for the mouth of the Columbia in September 1882 after considering data from extensive land and hydrographic surveys made to determine the feasibility and cost of the project. The Chief of Engineers approved the proposal; and in July 1884, Congress authorized the project with an initial appropriation of $100,000. The improvement called for a 4.5 mile long low-tide jetty, extending from near Fort Stevens on

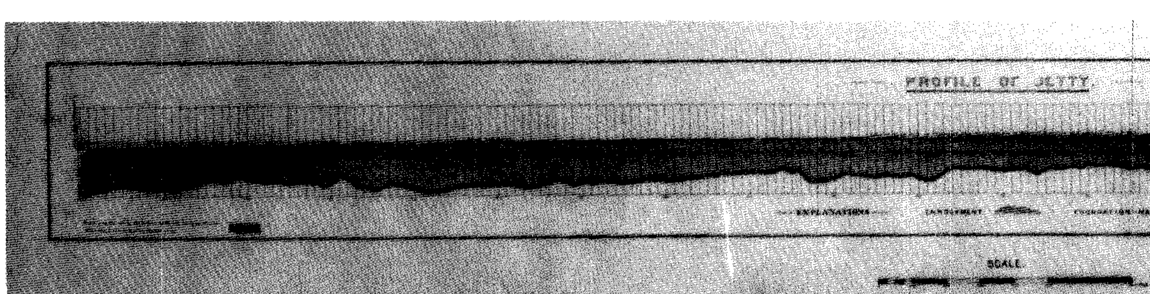


Columbia River mouth surveys of 1792, 1839, and 1885.

the south cape by a slightly convex curve northward to a point about three miles south of Cape Disappointment. The Board estimated the cost of the stone structure, which would provide a channel depth of thirty feet at low water, at $3.7 million.[5]

The object was to narrow the distance between Cape Disappointment and Point Adams at the mouth of the Columbia so as to direct the volume of the water into one deep channel. As the Board explained, the method advocated to achieve this goal was a jetty to direct the river's tidal flow "which has ample force and volume, but . . . requires regulation and direction." The proposed structure must be arranged so "as not to obstruct unduly the free entry of the flood tide into the basin near the mouth of the river from which it is to ebb and do the work required of it."[6] Powell had to position the jetty so that it would force the whole volume of the ebb through a limited, single channel of the bar, rather than allowing it to spread out and dissipate its energy through several channels.

Before work commenced on the jetty at the mouth of the Columbia River, it was obvious to the office of the Chief of Engineers that responsibility for projects in the Pacific Northwest should be divided between two men. In August 1884, Major Jones was assigned to supervise the improvements on the Williamette River above Portland; the construction of the Cascades Canal; and the work on the Upper Columbia, Snake, Cowlitz, and Clearwater Rivers. This left Powell with the improvement of the Columbia and Willamette Rivers below Portland, the works at Oregon's coastal bays and rivers, and the streams emptying into Puget Sound in Washington Territory. Under this arrangement, each office would have responsibility for one of the two major projects in the Northwest: the Cascades Canal and



Profile of Columbia River jetty.

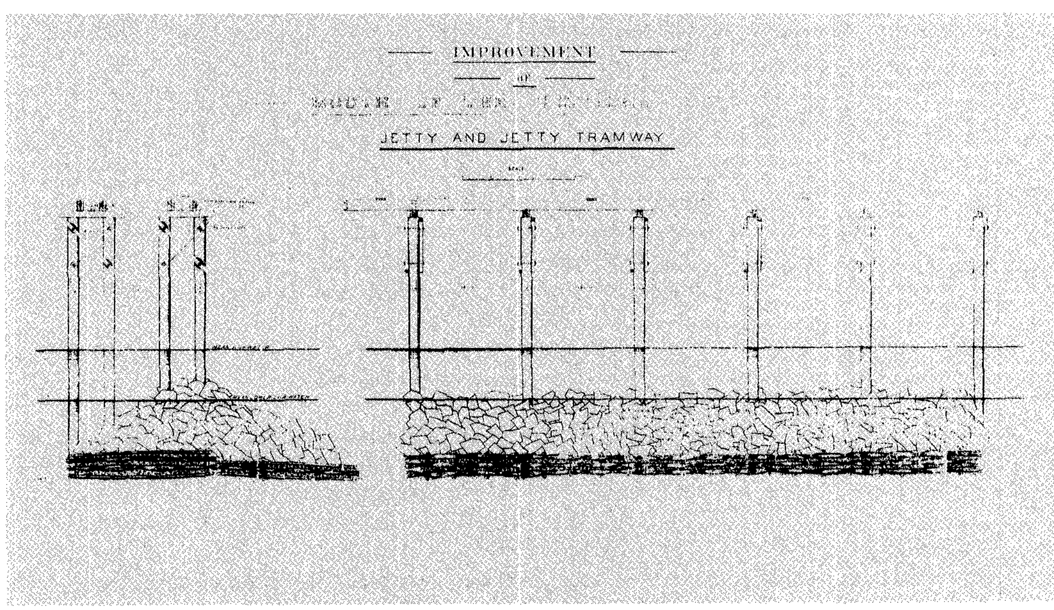
the jetty at the mouth of the Columbia. Offices for each man were located in Portland, and the division of authority was effected as work got underway on the jetty.[7]

In 1884-1885, Powell began work on the jetty project. He hired workers, ordered materials, and oversaw construction of riverside facilities, including offices, shops, a wharf, and a dock. His workers completed an approach trestle from the beach. They chose quarry sites for stone, built housing and dining facilities, and made final surveys. The appropriation for 1886 was $187,500; two years later it increased to $500,000.[8]

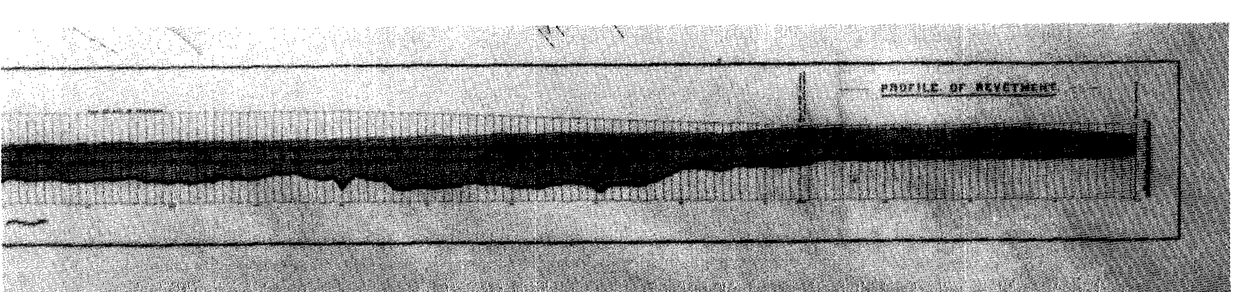
Completion of the south jetty at the mouth of the Columbia River required ten years and just under $2,000,000. Construction throughout this period followed essentially a three-step pattern. First, Powell built a double track tramway from the approach trestle on the beach to the starting point of the jetty. A steam locomotive and about 30 gondolas or flat-bed dump cars operated on the tramway, which was built above and ahead of the projected crest of the jetty. Placement of the foundation of the jetty into the water came next. After wood pilings were driven, brush fascines, one foot in diameter and eighteen feet long, were bound together by galvanized wire to form forty-foot wide "mattresses." These were laid on the floor of the sea and secured by piling and small stone. The mattresses minimized erosion of the ocean bottom on which the jetty rested. After some experimentation, Assistant Engineer Philip G. Eastwick, devised an efficient method of sinking the jetty-trestle pilings. Workers blasted wells in the sand with water jets and then drove the pilings into these holes, sometimes as deep as 22 feet.

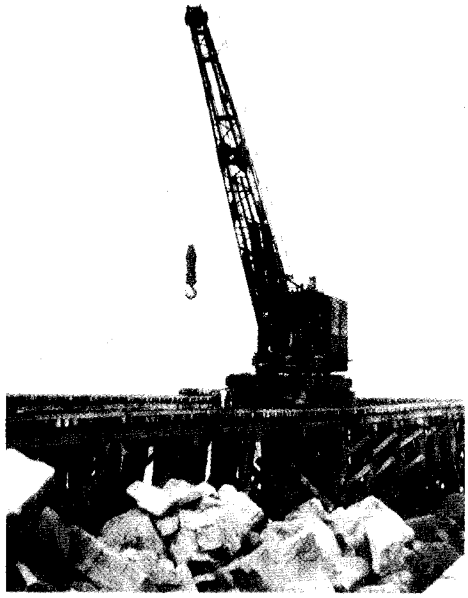
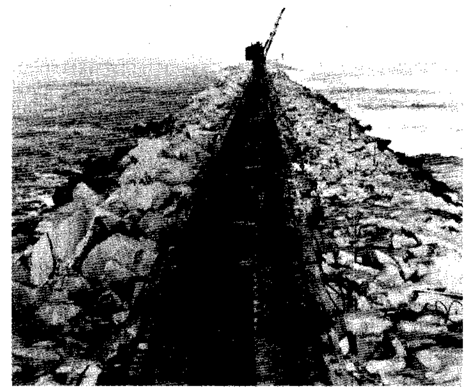
After the foundation had been laid, the tramway hauled large stones, barged from distant quarries over 100 miles up the Columbia and transferred to dump cars at the project wharf, to the end of the jetty and dumped them. The tramway method resulted not only in the breakage of many jetty stones, but in a somewhat haphazard assembly as well. Broken stone made the jetty weaker than specified. With some rocks falling so that their long axis was perpendicular to the structure instead of parallel to it, the force of the ocean water could more easily pick the structure apart. Each year a good deal of time and money went for repairs to sections of the jetty already completed. In 1892, more repair work was done than anything else.

Over the life of the project, equipment and techniques for placing the stone improved. A draftsman on the work designed a special self-righting dump car that saved time and increased the safety of hauling and placing the rock. The new-style dump cars, a modified



Profile of jetty tramway used at the Columbia River mouth.



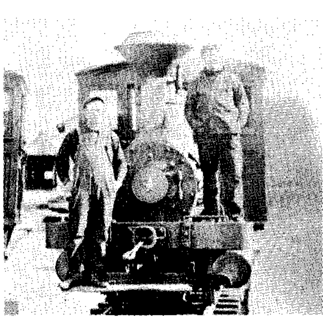
  

above, left to right: Jetty tramway built extending from shore; jetty stones dumped from cars on tramway; jetty progresses along length of tramway.

pile driver, and other equipment were built in the shops at the project site.[9]

As the trestle progressed into deeper water ahead of the jetty, the workers became more exposed to the hazards of wind and waves. Assistant Engineer Hegardt developed a great respect for the power of nature after working at the exposed end of the jetty. The rough ocean waters caused the outer portions of the tramway to sway so violently that he could not run trains on it. The sea would frequently break over the tracks with such force that workers had to give up the practice of suspending under the tracks overnight the inside mats used for the foundation. Hegardt reported that during the months of September and November 1890, 144 feet of tramway washed away and that only with great difficulty did he prevent more from going.[10]

After 1889, construction began to have noticeable, positive effects on the bar; and in 1893, a Board of Engineers convened to assess the results attained and to recommend any necessary changes to the original project. In its report, the Board described the jetty as "a long thin, narrow backbone of solid material resting upon a very doubtful foundation, against which the forces in action at the locality have accumulated large quantities of the shifting sands." The Board believed that the durability of the jetty depended upon the continued accumulation of this sand, for it served to break the force of the waves attacking the structure. To control the tidal flow across the jetty which removed the protective sand deposited along the base of the structure and to cut the damage to the jetty tramway from floating debris, the Board urged the construction of four groins on the north side of the jetty and raising the level of the jetty itself. The Chief of Engineers accepted these recommendations.[11]



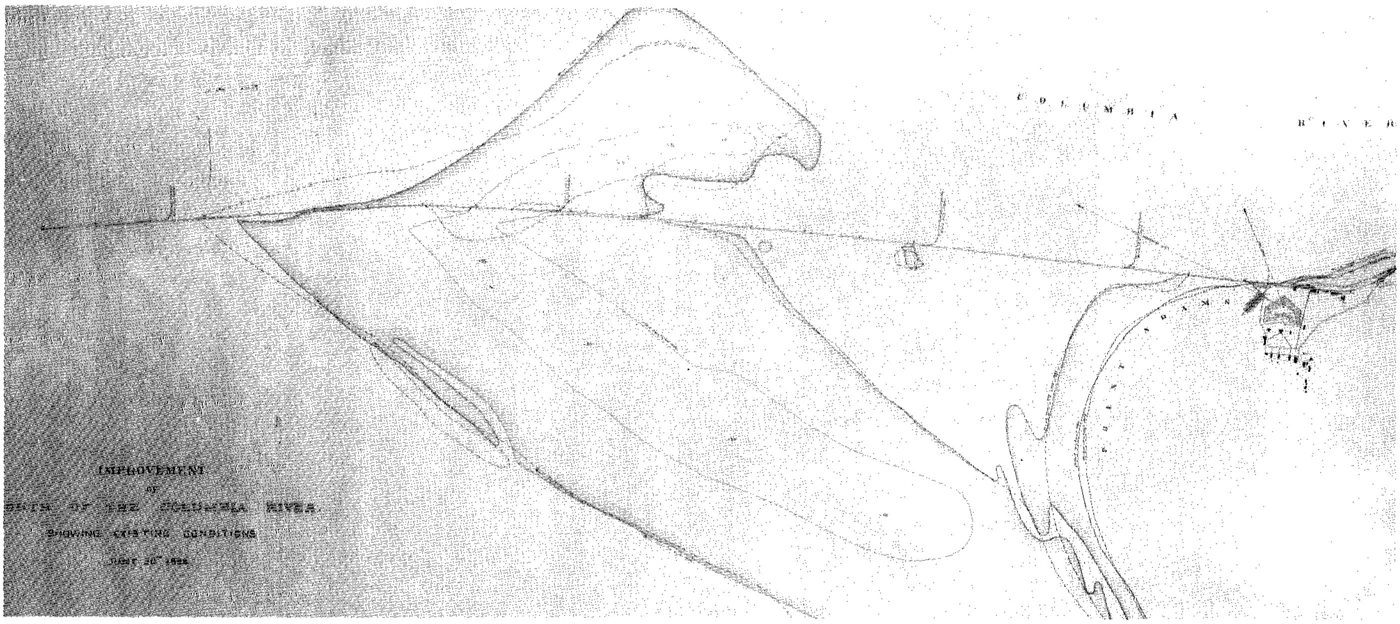
above: steam engine used to pull cars of stone along tramway.

When completed in 1895, the jetty measured 30 feet high at its crest and from 80 to 90 feet across its base. It maintained a height of ten to twelve feet above the mean level of lower low water except at the outer end where the height sloped sharply to four feet. Measurements in the channel over the bar showed that a minimum of 30 feet had been obtained by the improvement. In many places 31 feet of safe water could be relied upon. Benefits to navigation were substantial and quick to come. Within two years after completion of the south jetty, the value of tonnage passing over the bar more than doubled the average for the previous decade.[12]

Despite the benefits provided by the completion of the south jetty, substantial new work was necessary by 1902 in order to support navigation on the lower Columbia River. Annual surveys made at the mouth since 1897 showed that "marked shoaling" each year diminished the project depth. Nor was the channel stabilized as was essential for the ever-larger ships desiring entrance into the Columbia.

Thus, in 1902, the Board of Engineers submitted to the Secretary of War a project designed to eliminate the shoaling and re-establish a deep and dependable channel. The plan called for major repairs to the existing four-mile jetty, a 2.5-mile extension, and channel dredging. Project depth was to be 40 feet. Costs, estimated at $2,510,000, included $250,000 to re-outfit the old Army transport *Grant* as a dredge. The authorization for work on the south jetty also provided for a jetty on the north side of the mouth of the Columbia from Cape Disappointment, if that were necessary to obtain project depth.[13]

Except for damage caused by rough seas, work on the south jetty progressed



above: Chart of Columbia River mouth improvements.

satisfactorily. Despite much effort and expense to protect the wooden structures, thousands of feet of trestle washed away each spring. In the winter of 1905-1906, stormy seas destroyed over five miles of trestle. Even the wharves and approach tramway required annual repair and rails rusted away very rapidly. Awed by the power of the ocean, Colonel S. W. Roessler, District Engineer, wrote that "no language can adequately describe the fierceness of the onslaught. The place must be seen to be understood and appreciated. It is perhaps no exaggeration," Roessler concluded, "to say that there is no work in progress in the United States to-day at all comparable with this one in the difficulties, uncertainties, and dangers that arise at every stage of its construction."[14] By 1913, the district completed the new work on the south jetty at a cost of nearly $8,000,000. As reconstructed, the average top width of the jetty was 40 feet and the height above sea level varied from 10 feet at the shore end to 24 feet at the outer end. While the engineers made numerous minor changes, they again employed basically the same construction methods used for the original jetty.[15]

The work on the south jetty resulted in a channel depth of only 36 to 37 feet of safe water over the entrance. Therefore, the Corps decided to go ahead with construction of the north jetty so that the project depth of 40 feet could be accomplished. The cost of the 2.5-mile jetty was roughly $5,000,000. The engineers used the same methods of operation on the north jetty as they had employed on the south structure. Because of its more sheltered location, work proceeded more rapidly on the northern than on the southern one. The workers found it possible to construct trestle and place rock throughout the entire year, whereas work had to be suspended each winter on the south jetty.

Construction began in the spring of 1914 and was completed by May 1917. As finished, the north jetty had a top width of 25 feet and an elevation varying from 28 to 32 feet above mean lower low water. Surveys made the following spring showed the depth across the entrance at all places measured at least 40 feet. When completed, the jetties at the mouth of the Columbia River contained 9,000,000 tons of stone and were the largest in the world. This project, Colonel George A. Zinn reported in 1917, "made it possible for the largest vessels operating on the Pacific coast to enter and leave at all normal stages of tide and in any weather except during most severe storms."[16] Never again would vessels stranded on the bar be a common sight.

With the rubble stone jetty exposed to incessant wave action, normal repair operations by floating plant were impossible. Maintenance had to be carried out by constructing expensive trestle and was deferred until the work required would justify the cost. By 1931, the sea had flattened the south enrockment to the low-water level and had spread out the stone so that the width of the outer 2.75 miles was 200 feet at low-water level. From 1931 to 1936, R. E. Hickson—then senior engineer in the Portland District—oversaw the retopping of the south jetty to 25 feet above low water to within approximately 3,300 feet of the outer end of the enrockment. The reconstruction project added 2,200,000 tons of stone to the structure, with the average rock weighing 12 tons. However, constant wave action still eroded the outer end, moving stones weighing up to 25 tons each.

To halt the disintegration at the sea end, Hickson employed two methods. First he injected the outer end with 12,787 tons of hot asphaltic mastic to bind the stones into an impregnable mass, but it failed to prevent the continued breakdown of the end. Finally, a solid concrete terminal was constructed above the low-water level and this proved effective. As completed, the south jetty top width varied from 45 to 70 feet, with an elevation of 26 feet above mean lower low water. The base width of the outer portion measured approximately 350 feet, and the total height from the bottom reached up to 76 feet.[17]

Much of the original work on the jetty was the responsibility of Gustave Hegardt. For over fourteen years he ably directed the construction at the mouth of the Columbia, including the new military fortification at Fort Stevens built between 1896 and 1904. Robert E. Hickson, a junior engineer chiefly engaged in surveying at the mouth of the Columbia in the years of the century, later directed the rehabilitation of the jetties. Hickson served many years as chief of the engineering division in the Portland District and became an internationally recognized authority on jetty construction. Major General Cecil Moore, Portland District Engineer from 1937 to 1942, considered Hickson "a marvel on river and harbor work."[18]

Columbia River Fortification

In the period between the first and second jetty projects at the mouth of the Columbia, the Portland District also had responsibility for rebuilding the fortifications at that location. A product of military preparedness during the Civil War, the crumbling defenses at Forts Stevens and Canby had reached obsolesence by the end of the nineteenth century. In 1860, General Joseph G. Totten, in his important "Report on Military Defenses for the Pacific Coast of the United States," called for the immediate fortification of the mouth of the Columbia River, as the only good refuge along the Pacific Coast between San Francisco and Puget Sound.[19] At the ardent and persistent urging of General General Benjamin Alvord, the War Department in 1862 decided to construct coastal fortifications at the mouth of the Columbia River. Congress appropriated the necessary funds; and Lieutenant Colonel Rene De Russy, Chief Engineer, Department of the Pacific, dispatched Captain George Elliot of the Corps of Engineers to supervise the layout and construction of the fortifications.

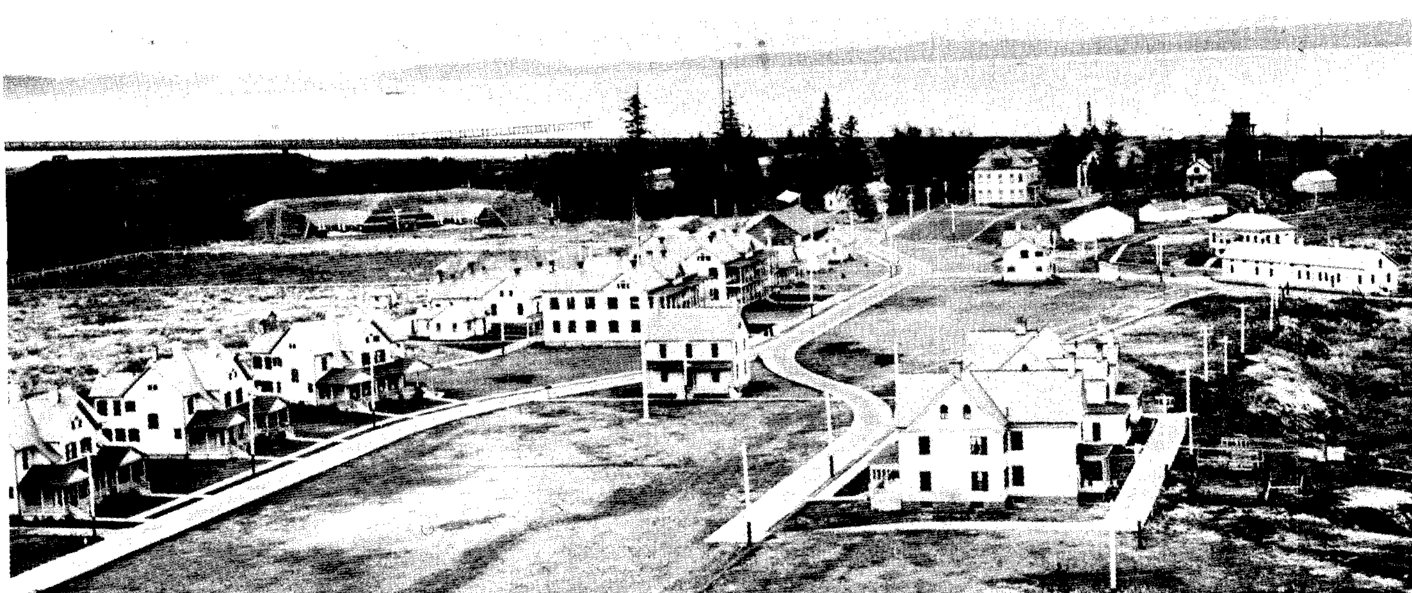
In July 1863, Elliot commenced his work and immediately encountered difficulty finding sufficient laborers "on account of the gold discoveries." Work at the site was laborious as "there was a great deal of timber cutting and clearing up of brushwood to be done . . . . Roads and paths were to be cut and at Point Adams it required twenty men for more than a month to clear the site of the fort of the fallen and decayed trees of immense size which covered it."[20] Elliot named the fort at Point Adams after the late Isaac Ingalls Stevens, Governor of Washington Territory and fallen Civil War general.

Fort Stevens—consisting of earth works, moat, powder magazine, and twenty-nine gun platforms—was completed and transferred to the army by April 1865. It took until June 1867 to receive and mount 26 guns in the earth works at Fort Stevens. These included one 15-inch smoothbore Rodman, seventeen 10-inch Rodmans, three 8-inch Rodmans, and five 200-pound rifled Parrotts. The 15-inch Rodman was a mammoth cannon, weighing 50,000 pounds and throwing 315-pound shells 3,800 yards using 50 pounds of powder.[21]

The historian Francis Fuller Victor visited the fort in 1871 and gave this description of the post:

> *There is nothing handsome in the situation of Fort Stevens. It occupies a low, sandy plain, and is just a little inside of the actual point of this cape [Point Adams]; but the fort itself is one of the strongest and best-armed on the Pacific Coast. Its shape is a nonagon, surrounded by a ditch, thirty feet wide. This ditch*

below: Overview of Fort Stevens housing.



is again surrounded by earthworks, intended to protect the wall of the fort, from which rise the earth-works supporting the ordance. Viewed from the outside, nothing is seen but the gently inclined banks of earth, smoothly sodded.

The view from the embankment is extensive, commanding the entrance to the river, the opposite fortifications, and handsome highlands of the north side, as well as a portion of Young's Bay. A system of signals is established between the two forts, and signal-practice is made a portion of the daily duty of the officers.[22]

The damp, rainy climate of the fort's location made drainage and decay constant problems, necessitating continuing repairs to the earth works and periodic rebuilding of the gun platforms by the Corps. In 1885, the Chief of Engineers described the defenses at the mouth of the Columbia River as

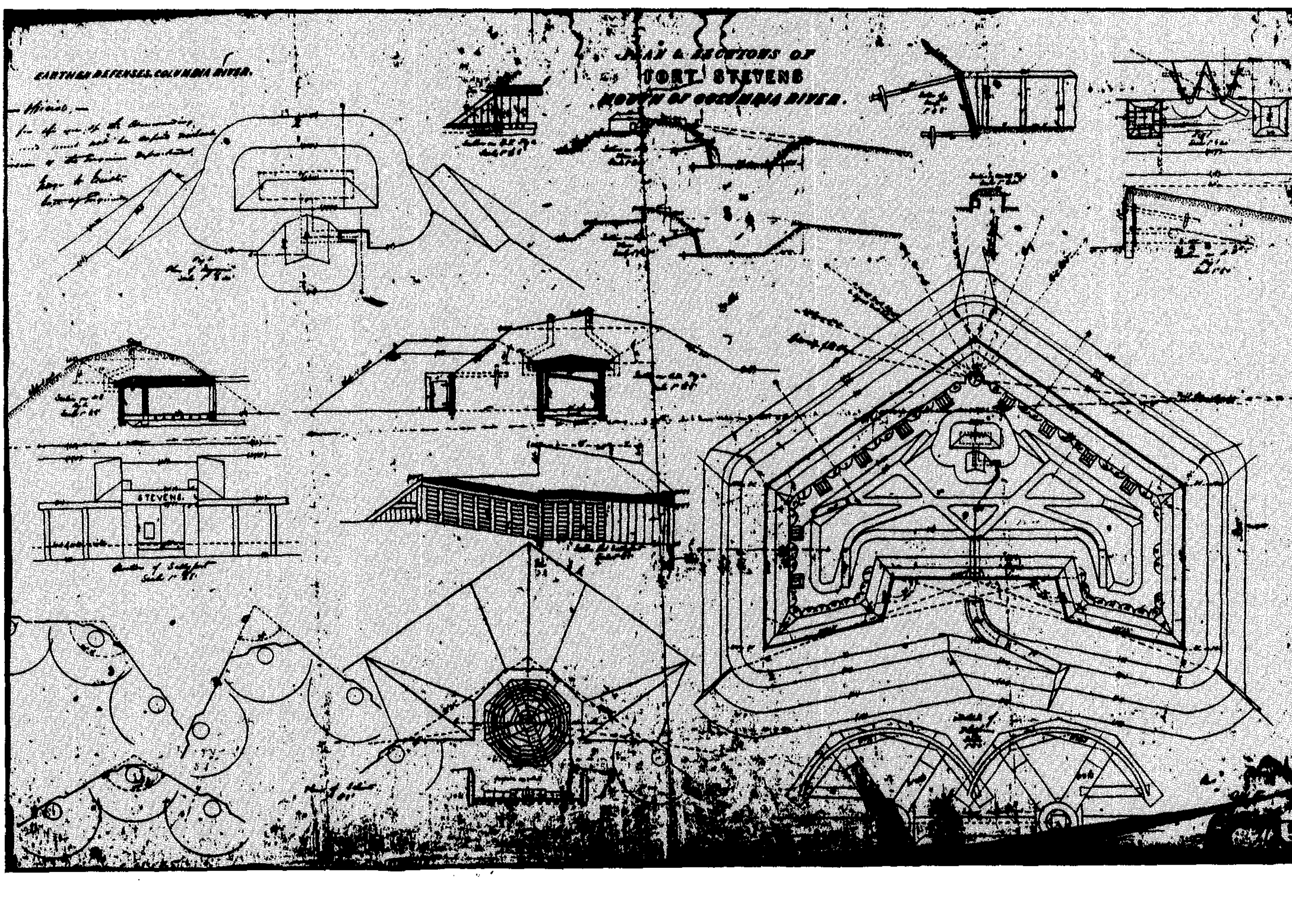
field works in character; they were built hastily during the late civil war in anticipation of complications with foreign powers. On account of increased penetration of present ordinance, and the decay of the greater part of the wooden platforms and magazine timbers, the works are of little value in their present condition except for drill purposes.[23]

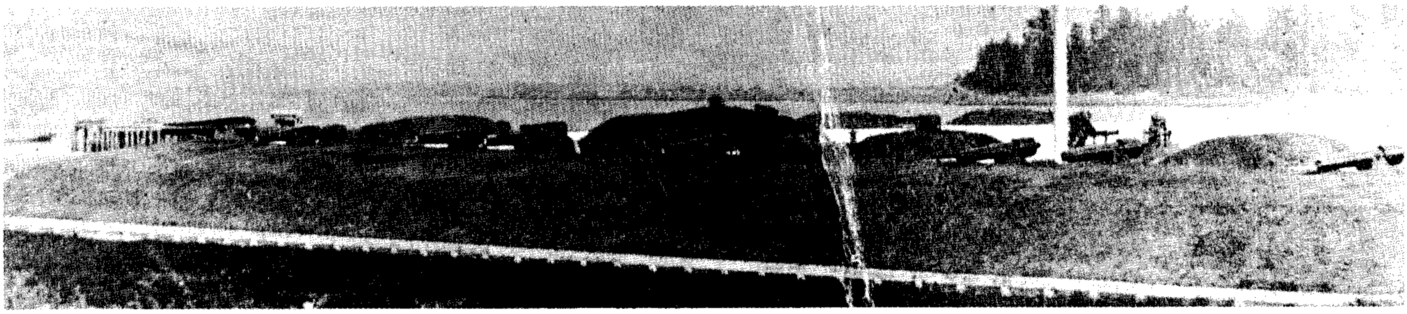
The following year seven guns platforms were rebuilt and other minor repairs carried out; but by then the fort had been abandoned as an active military post, the troops having been transferred across the river to Fort Canby in November 1884.[24]

In January 1886, a Board of Fortifications recommended that the defenses at the mouth of the Columbia be modernized, but it was nearly ten years before a Board of Engineers submitted a project to accomplish this goal. The plan called for batteries containing eight 10-inch high power guns, parados behind the 10-inch batteries, a battery for sixteen 12-inch mortars, as well as plotting rooms, ammunition conveyors, and an electric light plant. Captain Walter L. Fisk, Portland District Engineer, prepared the actual plans and estimates. Fisk's plans were approved, and he was authorized to purchase materials and to hire labor. He inherited an extensive plant already developed at Fort Stevens for the south jetty project and needed only to construct a concrete mixer building, add a steam shovel for excavating sand, and lay new railroad tracks. Gustave Hegardt, the assistant engineer in charge of the south jetty project also directed the work on the new fortification.[25]

Work on the emplacements began in October 1896 and the Chief of Engineers pressed for strict compliance with the established time-table for completion. However, this failed to

below: Plans for Fort Stevens





above: Fort Stevens before renovation work began in 1896.

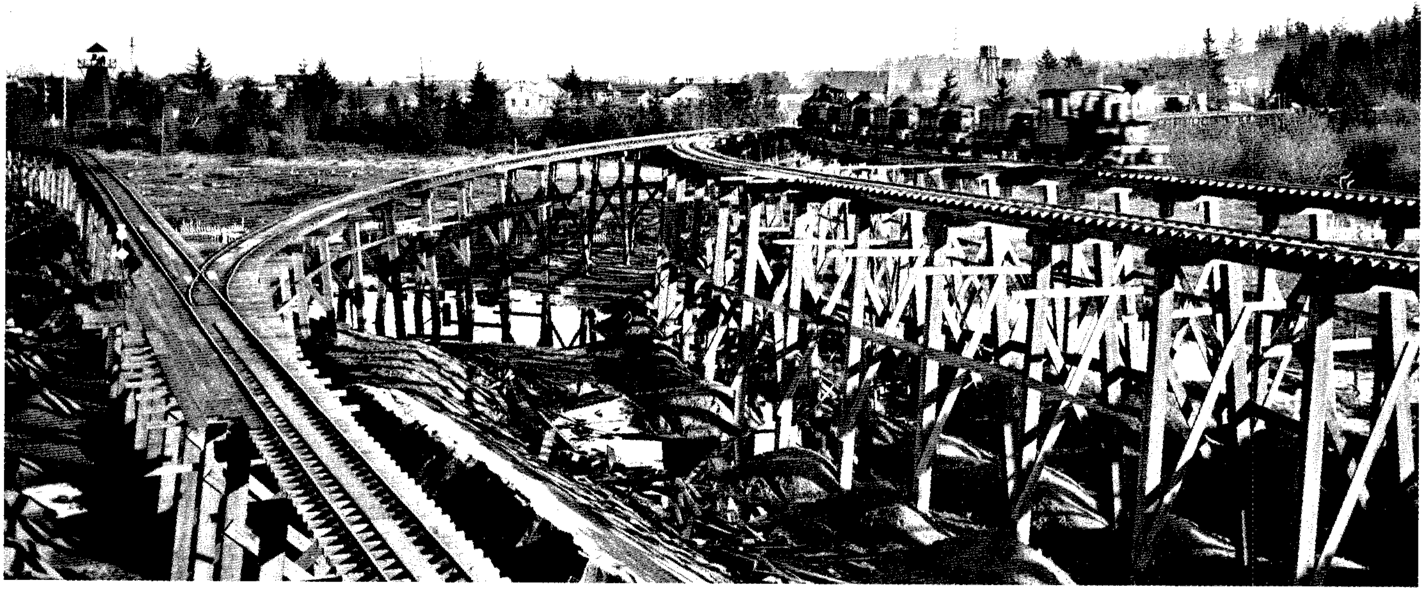
reckon with coastal weather conditions at that time of year. Captain Fisk later described work conditions as occurring during "the worst of the Oregon rainy season; most of the laying of concrete and a part of the construction of the plant was carried on in nearly constant rain and cold winds of high velocity. All of the workmen were compelled to wear rubber or oilcloth the greater part of the time." Being so encumbered, Fisk found it "impossible to work the men to the best advantage, and sickness, resulting from exposure, continually interfered with the work. Only one death from these causes occurred, but as high as 13 men out of a force of 160 were sick at one time with la grippe and pneumonia."[26]

In order to complete the emplacements on time, Fisk worked his men on 11-hour shifts a day. In addition, ocean storms delayed by two months construction of the wharf which had to be one-half mile long in order to safely receive the rock and sand barges. Because of the pressures of time, the Chief of Engineers gave Fisk considerable discretion in the actual planning and constructing of the batteries. He authorized Fisk "to prepare the plans in accordance with his best judgment after considering the indorsement of the Division Engineer . . . and to begin construction at once, without sending plans for further approval."[27] For efficiency, Captain Fisk decided that all work on the project would be carried out by the hired labor and materials purchased by sealed bid.

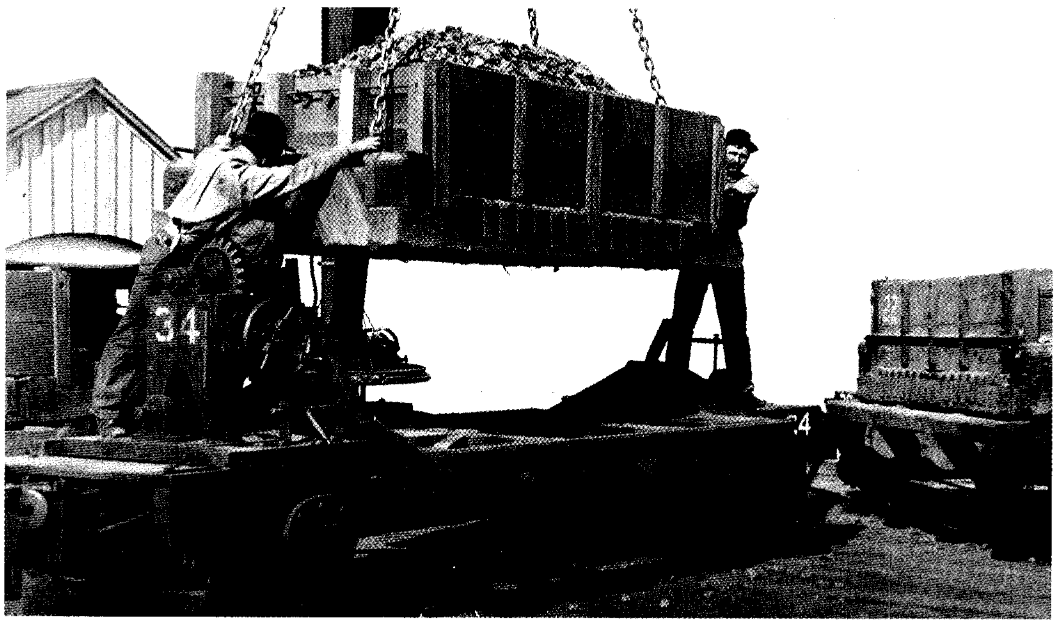
By 1899, Fisk had constructed five more emplacements for the new west battery, as well as an eight-gun battery of twelve-inch mortars. The main problem encountered in the works arose from leakage through cracks in the concrete walls and ceilings of the shell rooms and magazines. Adding to this dampness was the natural condensation on the walls due to the lack of ventilators in some of the rooms; eventually ventilators had to be added to all of the rooms that lacked them. The average annual rainfall of 77 inches aggravated the drainage problem. Stopping the leaks required a good deal of experimentation by engineer Hegardt. He found that asphalt, boiled linseed oil, and a waterproofing mix consisting of lye, alum, water, and cement all gave good results when carefully applied in various combinations.[28]

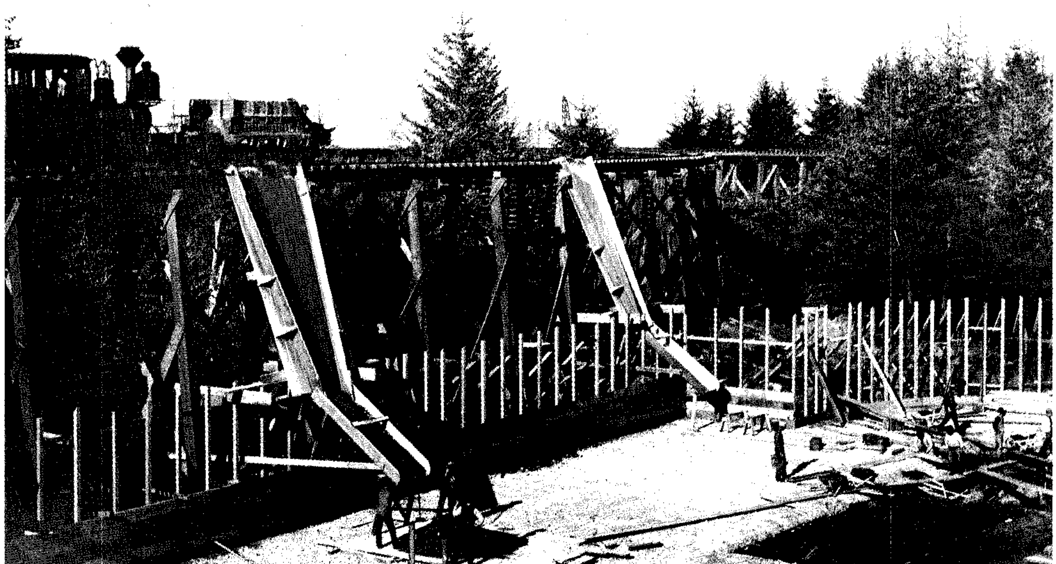
In March 1899, Major Fisk recommended a revised fortification plan with eight more emplacements for batteries of various caliber guns. The Chief of Engineers approved the proposal without exception, but revised the actual plans to cut costs. Not all of these emplacements actually were built. Finally, the Corps removed all of the obsolete weapons in the old earthwork fort, except for the 15-inch Rodman smoothbore, and sold them for

Horse power used for improvement work at Fort Stevens.

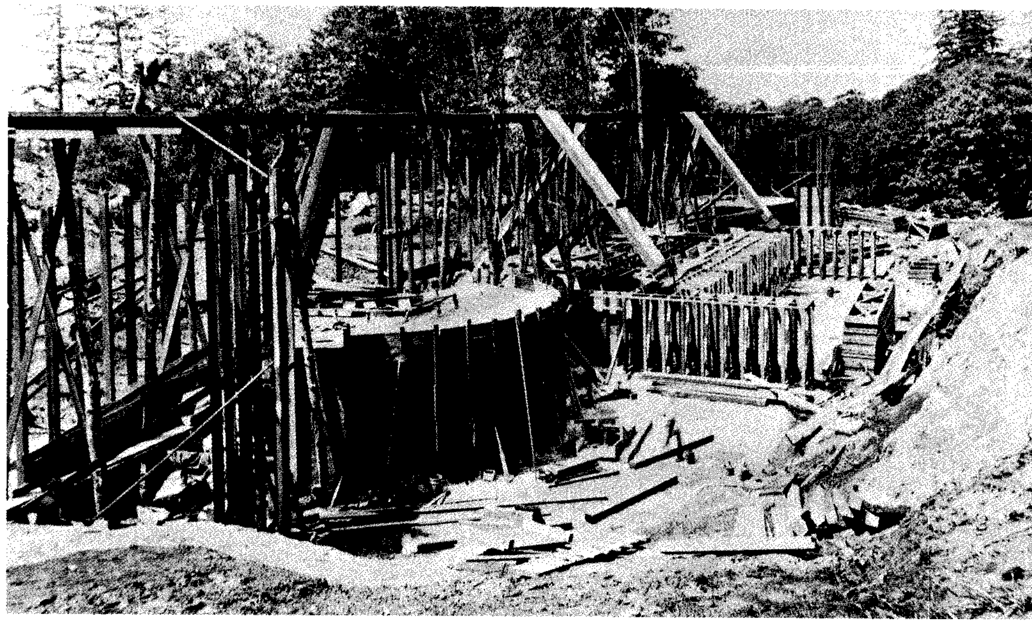


above: Tramway system used for transporting material from quarry to Fort Stevens construction site.
right: Tramway cars are loaded for trip to work area.



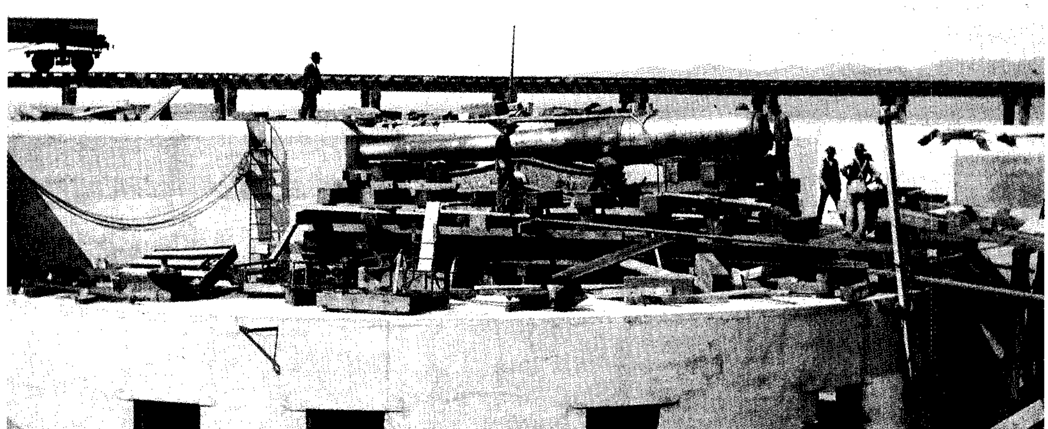


At construction site, car load is dumped down chute to work area.



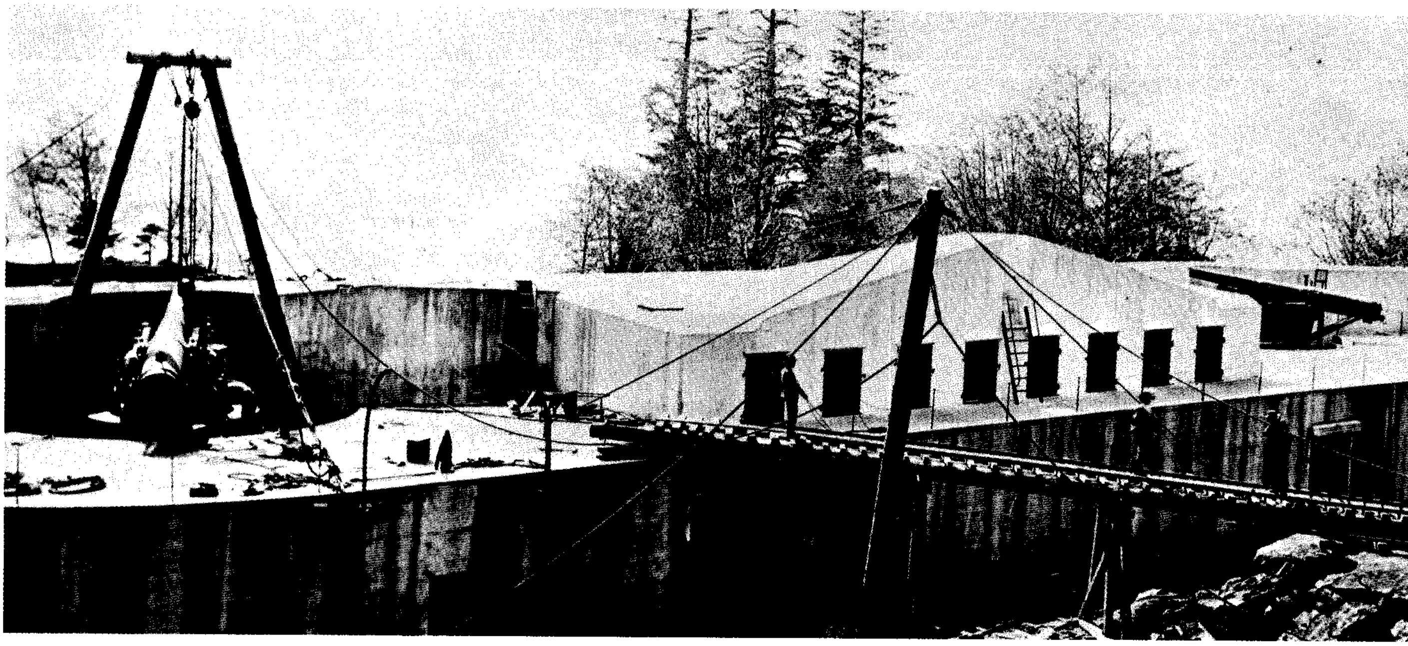
Fort Stevens construction progresses as concrete gun mounts are formed.

above: Guns arrive by barge on the beach and are moved to construction site by horses. right: Guns are placed in position atop newly constructed walls of Fort Stevens.

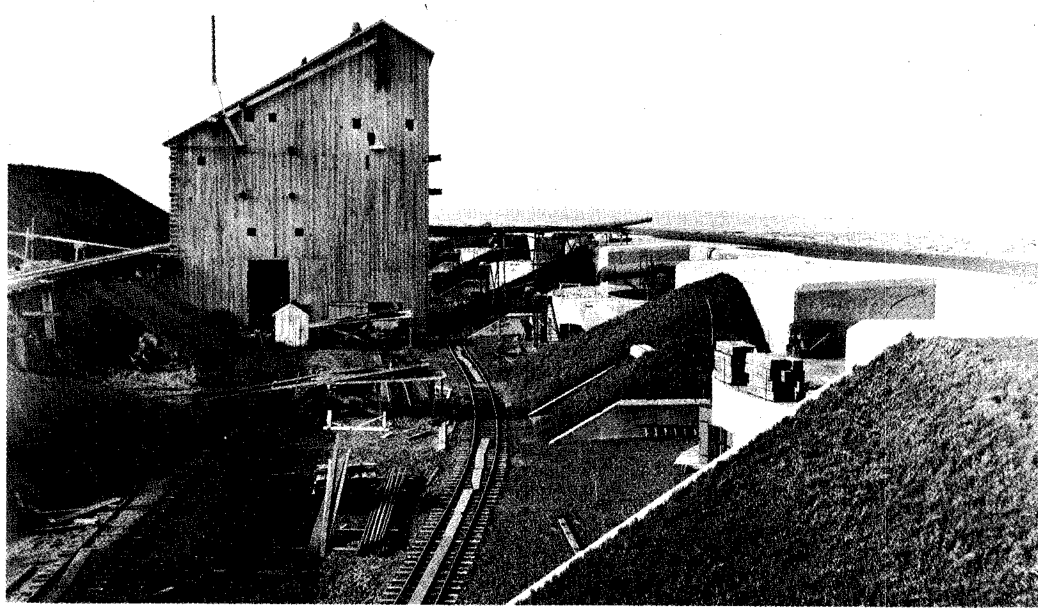


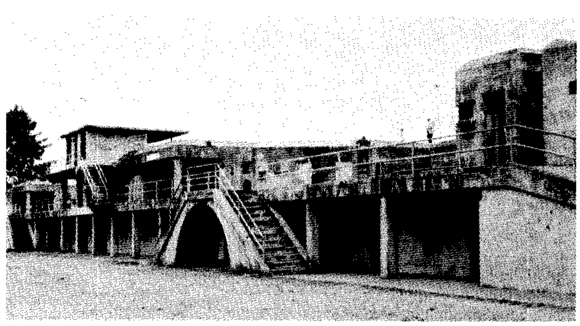
scrap. They then built new concrete emplacements to house one 15-pounder and two 6-inch rapid fire guns. The engineering force accomplished this work by 1902, along with a revised electrical system, mining casemates, and cable tanks for laying mines.[29]

Relations between the artillery units who regarrisoned Fort Stevens and the Corps of Engineers who continued to use the plant and equipment on the military reservation were not always smooth. Target practice by the artillery units often interfered with work on the south jetty. For example, in June 1908, Assistant Engineer Gerald Bagnell complained to Lt. Colonel Solomon Roessler, District Engineer that "sometimes we are not even notified in advance that this is going to be done, as ordinary courtesy would seem to demand . . . . Today I was not aware they were going to practice until I saw a soldier stopping rock trains."[30]



above: Construction on Fort Stevens nears completion with placement of last guns.
right: View along length of work area shows how Fort Stevens is below ground level and almost invisible from ocean.





Today, Fort Stevens is a park open to the public.

Fort Stevens and its sister installations continued to serve as active coastal defense works until the close of World War II. In fact, Fort Stevens was the only military installation in the continental United States to receive direct enemy bombardment during World War II. On the night of 21 June 1942, a Japanese submarine surfaced and fired nine rounds of five-inch shells at the post. The harbor defenses received no damage and suffered no casualties. Because the submarine stayed out of gun range, the frustrated soliders could not return fire. On 30 June 1947, the Army closed Fort Stevens and sold its property as surplus.[31]

Portland-to-the-Sea Ship Canal

Portland, Oregon, located ten miles above the confluence of the Willamette and Columbia Rivers and 108 miles above the mouth of the Columbia, owed its existence and early prominence to its river site. Strategically situated in a region rich in natural and agricultural resources, the city's early growth and prosperity seemed preordained. The Columbia and Willamette Rivers opened up their respective drainage basins and made them tributary to Portland. The continued growth and prosperity of Portland depended upon the development of its port as well as improvement of the river. This required the annual dredging and maintenance of the channel from Portland to the sea and up-grading of the harbor facilities. The Port of Portland Commission, created by the state legislature in 1891, had responsibility for channel dredging and harbor development in the Williamette River from the city to its mouth. Channel dredging from the confluence of the rivers to the sea was the job of the Corps of Engineers. The Port of Portland financed its activities with funds raised by taxes and the sale of bonds; by 1932 the Port had spent almost $14.4 million on dredging and channel improvements, while during the same forty-year period the Corps expended $10.7 million for its channel work.[32]

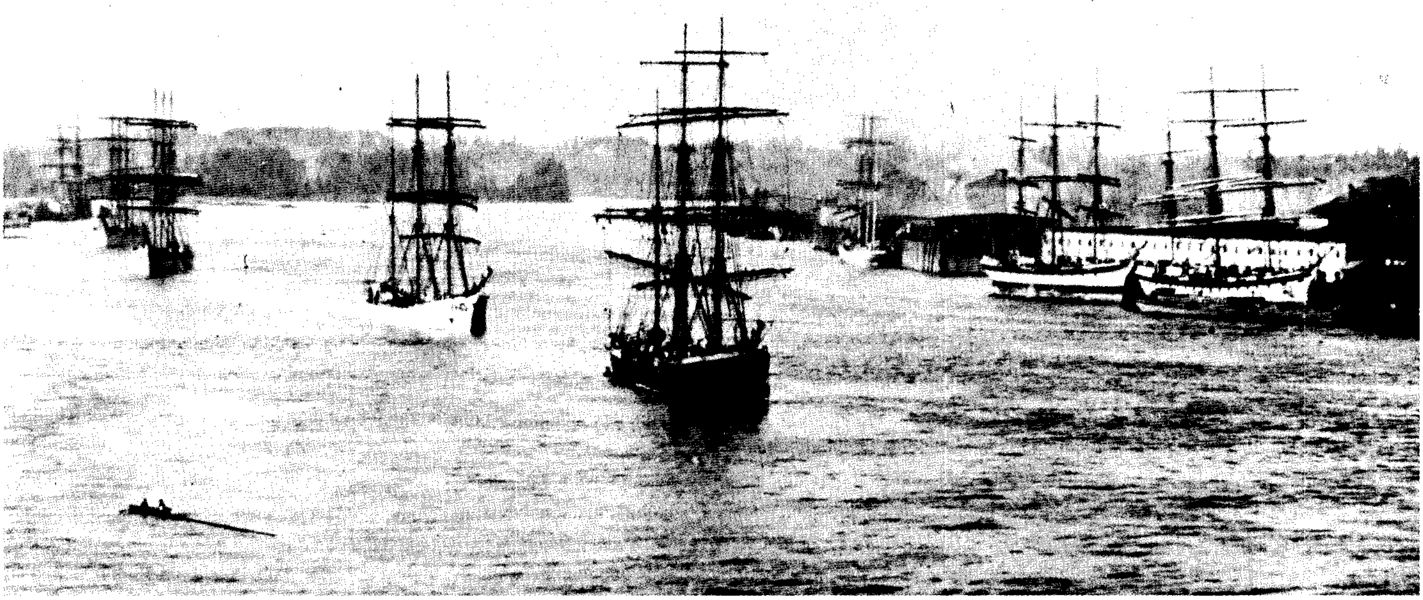
During the 1890s, the Port struggled to create a 25-foot ship channel to the sea, but that depth was not achieved until the first decade of the 20th century when the Corps took over the project. In 1891, Major Handbury, District Engineer responsible for improvement of the Williamette River and lower Columbia River and its tributaries, recommended a plan for a 25-foot channel. As he put it, "the necessities of the commerce and trade of Portland are such that the deepest draught vessels passing the bar at the Mouth of Columbia River should be permitted to pass to and from that port without lighterage."[33]

His proposal was approved but for several years congress supplied inadequate appropriations to accomplish this objective. Until the Corps revised the project again in 1902, the Port of Portland attempted to maintain satisfactory depths as outlined by Major Handbury in 1891. But the Port was only partly successful, since depths at most locations on the lower Columbia River were only 20 to 23 feet. The Chief of Engineers permitted Handbury to serve as a special consultant to the Port, and the first chief engineer of the Port of Portland came from Major Handbury's staff.[34]

The growing trade on the Columbia River finally made it possible for the Corps of Engineers in 1902 to get enough money from Congress to begin improving the channel from Portland to the sea to a depth of 25 feet.[35] The nature of this commerce and its dependence on navigational improvements was noted by District Engineer William C. Langfitt in 1903. He pointed out to the Chief of Engineers that the improvement of Columbia waterway was "of the utmost importance to the entire northwest section of the country" because it was the best natural outlet for the region's produce to the markets of the world.[36] One year later he reported that "the river is not now available for vessels of the larger draft to Portland, and on this account it is widely claimed that considerable transport and other business have been lost to this community."[37]

In the 1902 River and Harbor Act, $225,000 was appropriated for the Columbia channel, all of which went to dredging. The U.S. dredge *William S. Ladd* and a dredge from the Port of Portland did the work. By the end of 1903, tonnage over the Columbia River bar grew to 1,517,000 tons. Insufficient funds made it impossible to maintain the river at full project depth for a few years. But after 1907, 25 feet of safe water was accomplished. The Portland District maintained this level until 1912 when plans were made for further improvement.[38]

below: Sailing vessels in early harbor of the city of Portland.



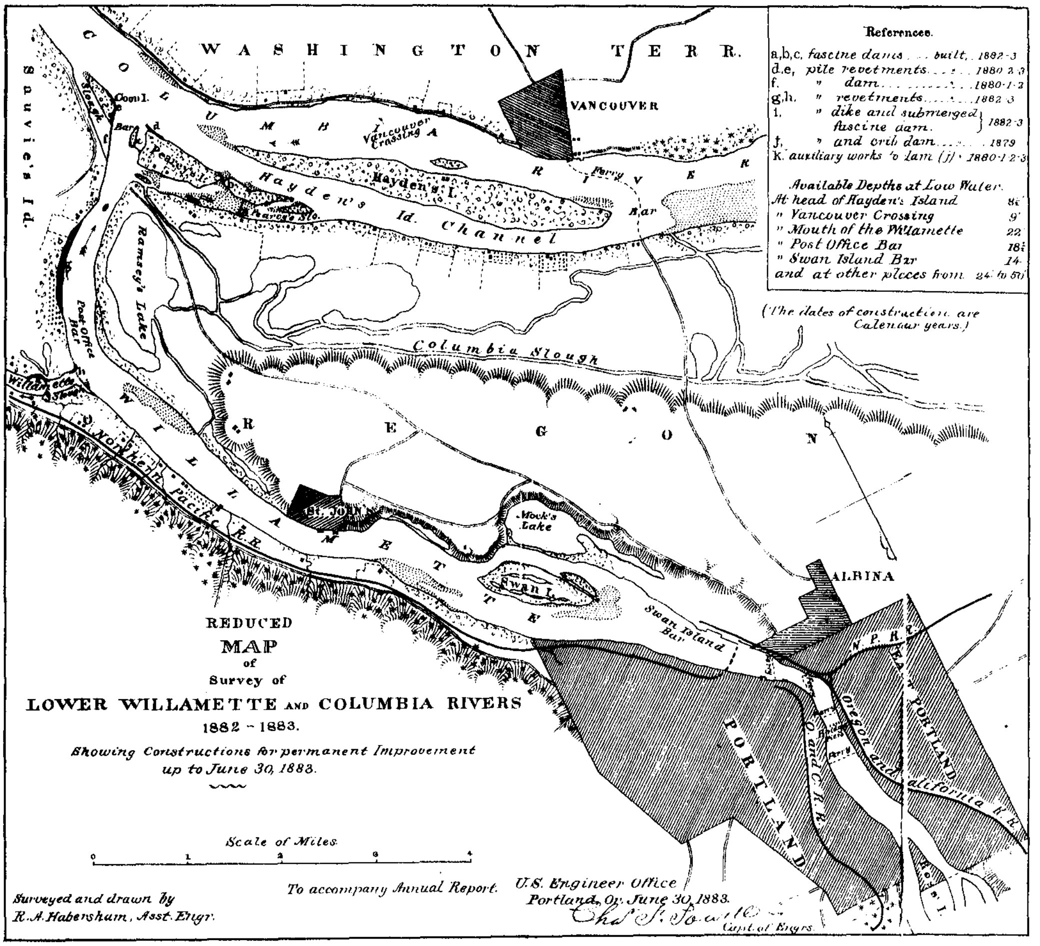


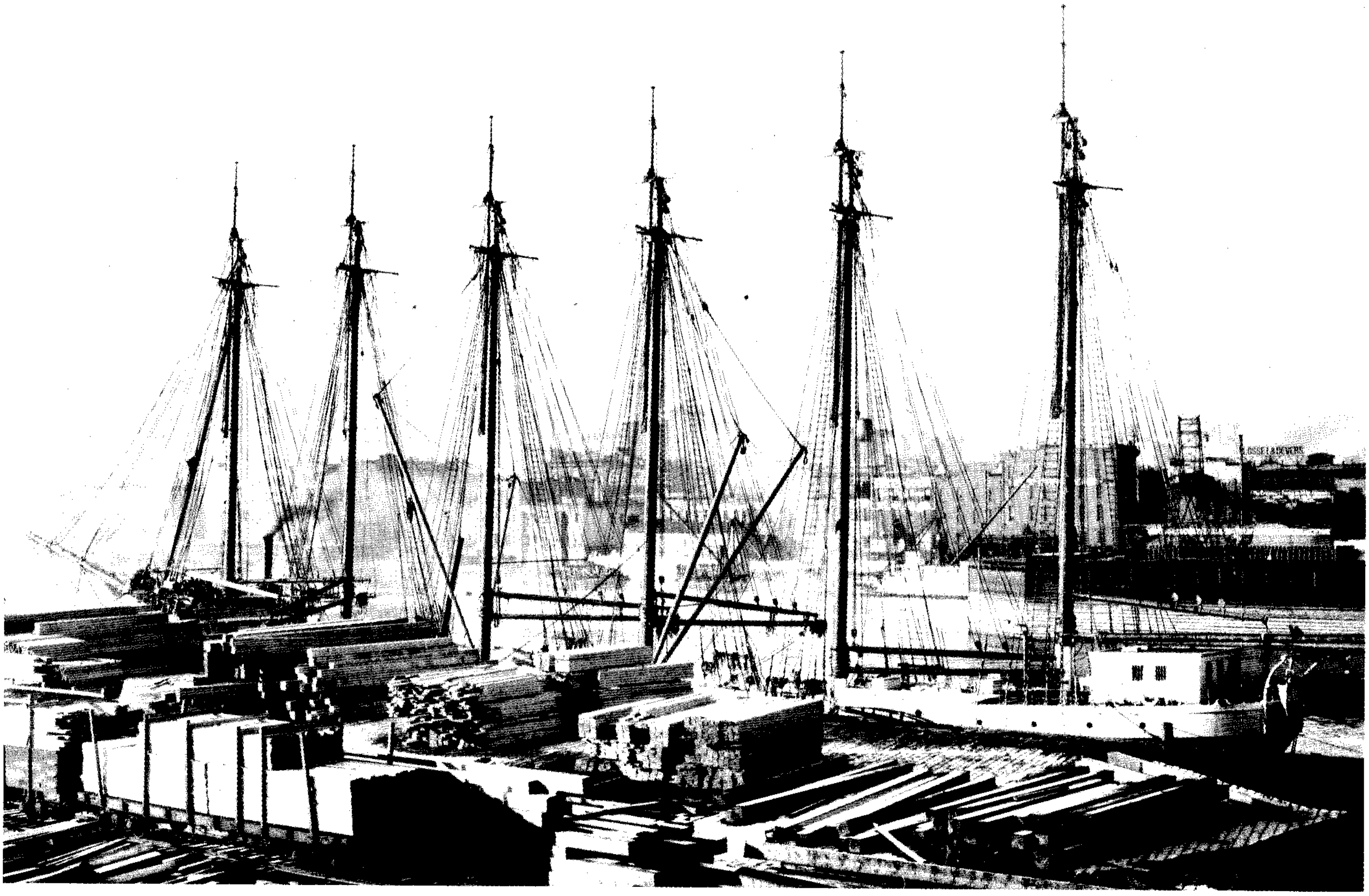
Chart showing Lower Willamette River survey.

The increased dredging activities in the Pacific Northwest after 1891 required new mooring facilities to service adequately the growing Corps of Engineers floating plant. Before 1903, the govenment docks occupied the site of the old Oceanic Terminals on the west side of the Willamette River just north of the Broadway Bridge. The first of three parcels of land for the new moorings, acquired in 1903, was located on the St. Helens Road on the west bank of the Williamette River just past the old Portland Gas and Coke Company plant.

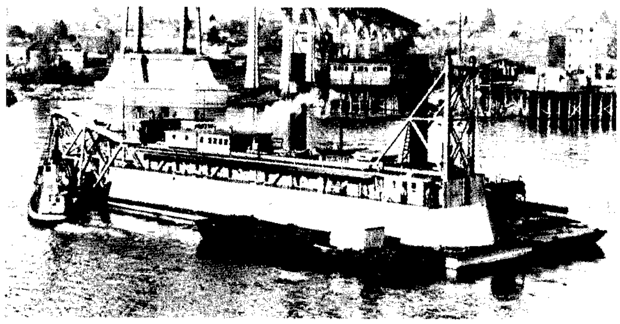
The new moorings soon became busy as vessels were added to the Corps fleet. In 1903, the Corps of Engineers remodeled the hydraulic dredge *Chinook* and in 1904 built two boats, the tug *Arago* and dipper dredge *Wallowa.* The snag boat *Mathloma* was rebuilt in 1906. The 18-inch pipeline dredge *Oregon* joined the fleet in 1907 and the hopper dredge *Clatsop* in 1908. In 1914, the 260-foot long, 24-inch pipeline dredges *Wahkiakum* and *Multnomah* went into service. The floating pipelines of these dredges averaged 1,800 feet in length, made up of 60-foot sections of 24-inch steel pipe supported on wooden pontoons and connected by rubber sleeves. When in operation, the pipeline was set up across the current and anchored both at the end and at the elbow of the pipeline. During October 1925, the *Wahkiakum* set an operational record by running non-stop for 221 hours and 45 minutes while cutting a channel 3.5 miles long and 300 feet wide in the lower Columbia.[39]

While large oceangoing ships could cross the bar at the mouth of the Columbia, many ships still had to unload at Astoria because they could not navigate the channel to Portland. The increased freight rates resulting from transfer to smaller-draft boats or to railroad cars adversely affected commerce in Portland. Thus, in 1912, a plan was approved for establishing a navigation channel from Portland to the sea, 300 feet wide and 30 feet deep. The Portland District used the two 24-inch pipeline dredges, *Multnomah* and *Wahkiakum,* to do the bulk of the dredging. The Corps of Engineers and the Port of Portland shared responsibility for the project. The federal portion of the cost of the channel was $3,770,000 for new work, and a maximum of $300,000 per year for maintenance. Most Corps work consisted of removing the material deposited by the annual freshet. The Port was charged with maintaining a depth of 30 feet in all project sections of the Willamette River (Broadway Bridge to the mouth) and, in addition, meeting annual maintenance costs of the Corps in excess of $300,000. This additional expense usually amounted to about $50,000 per year.[40]

The Corps attained the project depth in the channel in 1918, just one year after



above: Lumber, a booming industry, required sailing ships to visit early Portland. right: The dredge Wahkiakum in the Lower Willamette River.

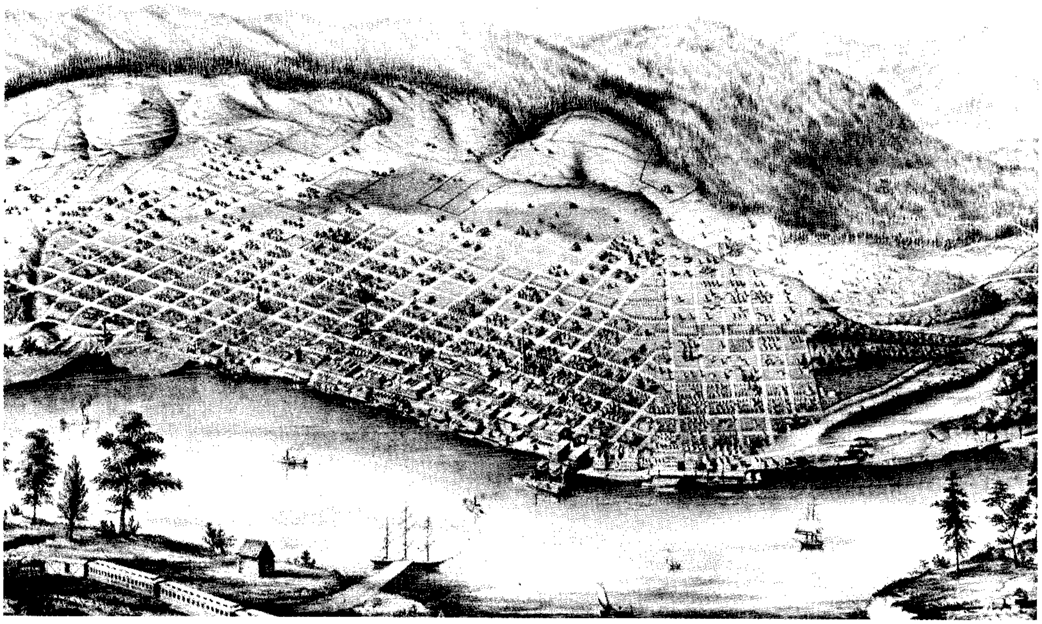


completion of the north jetty at the mouth of the Columbia River.[41] Writing in 1923, Major Richard Park, District Engineer, assessed the benefit of the work and found that large vessels could "now arrive and depart from Portland at all hours and seldom have to wait for tides." This led to a "large saving in freights on the commerce handled in ocean-going vessels on the lower Columbia and Willamette Rivers." He noted that "the saving last calendar year on a total of 4,163,554 tons is estimated to have been $9,857,622.98."[42]

Port improvements led to a five-fold increase in lumber exports between 1919 and 1926. Indeed, by 1926 more wood products moved from Portland than any other city in the world, and over fifty steamship lines used the port. The addition of four modern terminals made Portland's harbor one of the finest in the world at the time. No other improvement on the Portland-to-the-sea navigation channel was needed until 1930.

The Dalles-Celilo Canal

The Dalles-Celilo Canal has often been referred to as the skeleton in the closet of the Portland District. For many years after completion it was virtually unused. When it finally did bear a substantial level of traffic, the construction of The Dalles Dam permanently flooded it. Yet there were valid reasons for building the canal and for the delays in initiating and completing the project. Congressional reluctance to fund improvements at the site stemmed from questions concerning the best method for overcoming the rapids, from large appropriations already committed to numerous expensive ongoing projects in the Pacific Northwest, and from the slowness of the Corps in finishing the Cascades Canal. But with the completion of the Cascades Canal seemingly near in the early 1890s, the last point, at least, appeared resolved. The series of four falls between The Dalles and Celilo constituted



above: Bird's eye view drawing of Portland in 1870.
below: Drawing showing the vast development of Portland by 1890.

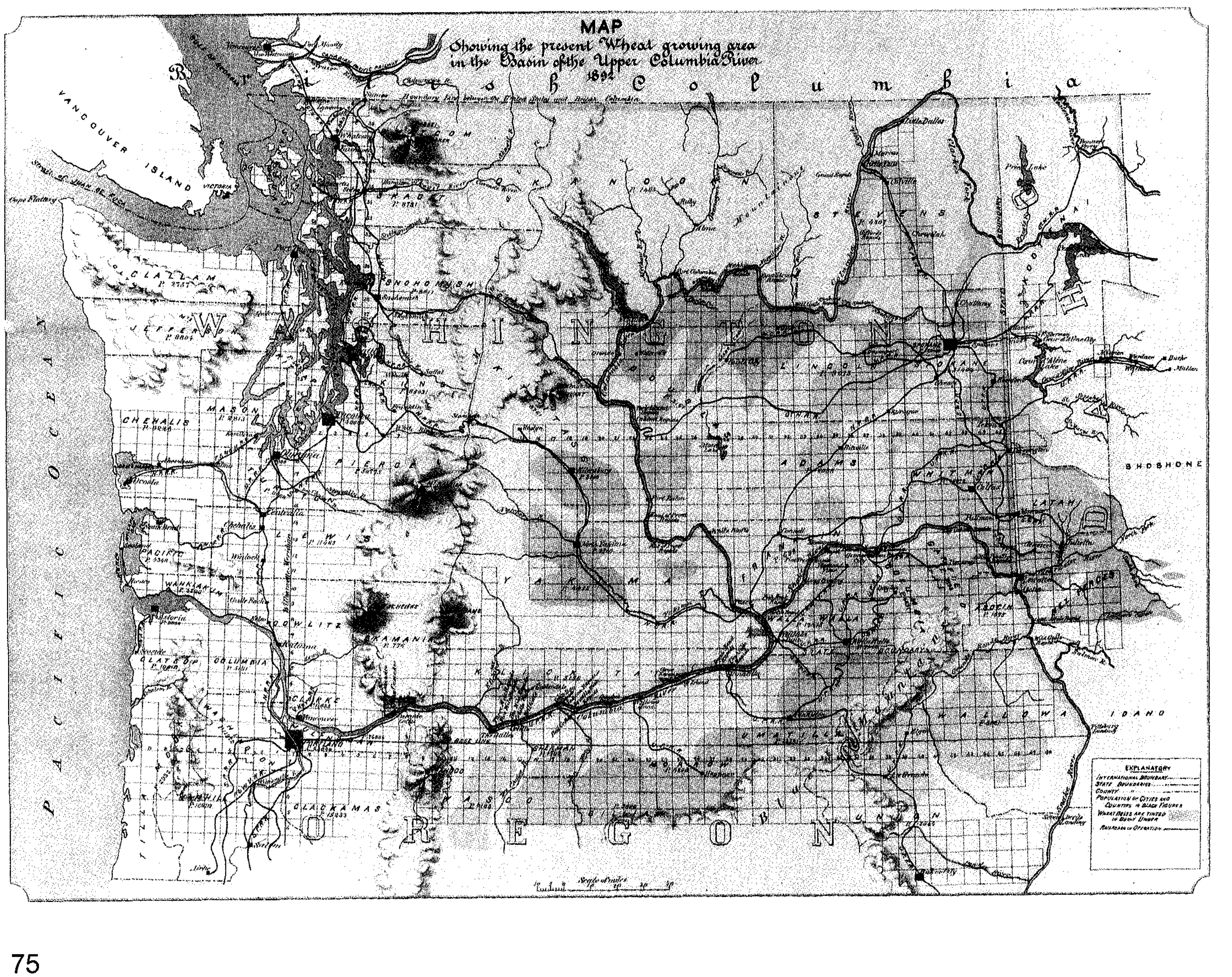
the sole physical block to open river navigation between Astoria near the mouth of the Columbia and Priest Rapids, Washington—a distance of 407 miles.

The demand for open navigation on the Columbia River came from the great wheat producing region east of the Cascade Mountains. A Board of Engineers convened in 1893 to study a project for overcoming the rapids, reported "that in 1891 about 15,000,000 bushels of wheat were shipped to the Pacific coast from the country which would be . . . affected by the removal of these obstructions at The Dalles." The existing rail system not only proved unable to transport the entire crop in a timely fashion, but also charged monopoly rates. Pointing to a general reduction in freight rates from the recently completed state portage railway at the Cascades, the Board felt certain that water competition on the upper Columbia would generate similar effects on transportation costs.

While admitting that at the time no commerce existed on the river above Celilo, the Board had no doubt "that when the obstructions to navigation near The Dalles shall be removed there will be a commerce, although the extent of its development cannot be foreseen." Unwilling to predict the future extent of navigation once the river obstructions were overcome, the Board neverthless felt confident that "an unobstructed waterway to the sea will act as a corrective of excessive rates of transportation by rail."[43] The rationale for a project to surmount the obstruction at The Dalles seemed clear, but the best method for doing so was less obvious.

As early as 1874, the Corps of Engineers studied the feasibility of overcoming the obstructions to navigation in that stretch of the Columbia River and reported that a canal and locks were practicable. Engineers made further examinations between 1879 and 1882, and in 1889 a Board recommended a boat railway as a cheaper solution to the problem than a canal and locks. The proposed plan called for hydraulic lifts that would remove the boats from the river at the foot of The Dalles Rapids and return them to the river at head of the Celilo Falls. An eight-mile long railway transported the boats between the two points. The equipment consisted of two cars and four engines, capable of passing eight boats of 600 tons in each direction in 12 hours. The Board estimated the cost of the whole system, including necessary buildings, at $2,690.356.[44]

Congress liked the idea and between 1894 and 1896 appropriated $250,000 towards its construction. The acquisition of right-of-way proceeded slowly, however, and nothing was done to actually construct the boat railway prior to 1900. Finally, after careful study by two district engineers, a plan was submitted to the Secretary of War in 1903 calling for improvement of the Columbia between Celilo and The Dalles by constructing a canal. It was to run 8.5 miles upstream from the foot of The Dalles Rapids to the head of Celilo Falls. The canal itself would be 65 feet wide and 8 feet deep with four locks. The locks, as modified, were 45 feet wide and 300 feet long with one at Celilo, one at the head of The Dalles Rapids, and a double lock at the foot of The Dalles Rapids (Big Eddy). The combined lift of the Tandem Locks at Big Eddy was 69 feet—rather high for a river canal. The canal passage contained a number of passing basins to facilitate the flow of traffic in the waterway. Culverts built around the locks maintained the water level in the pools between

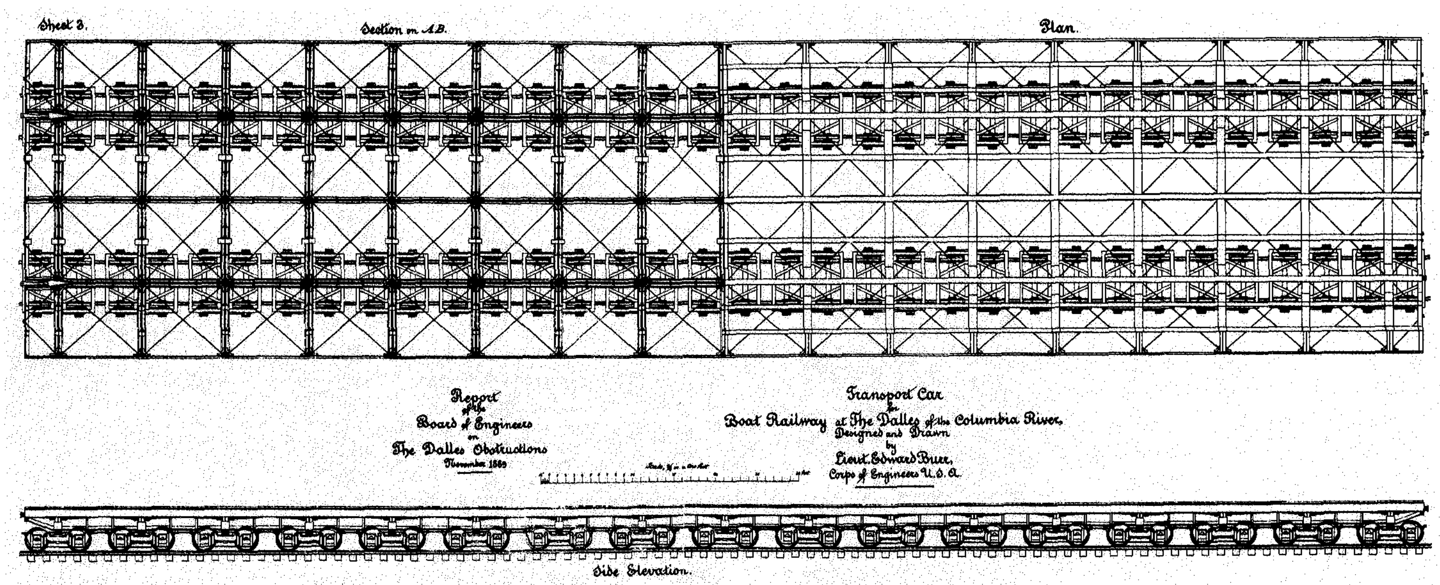


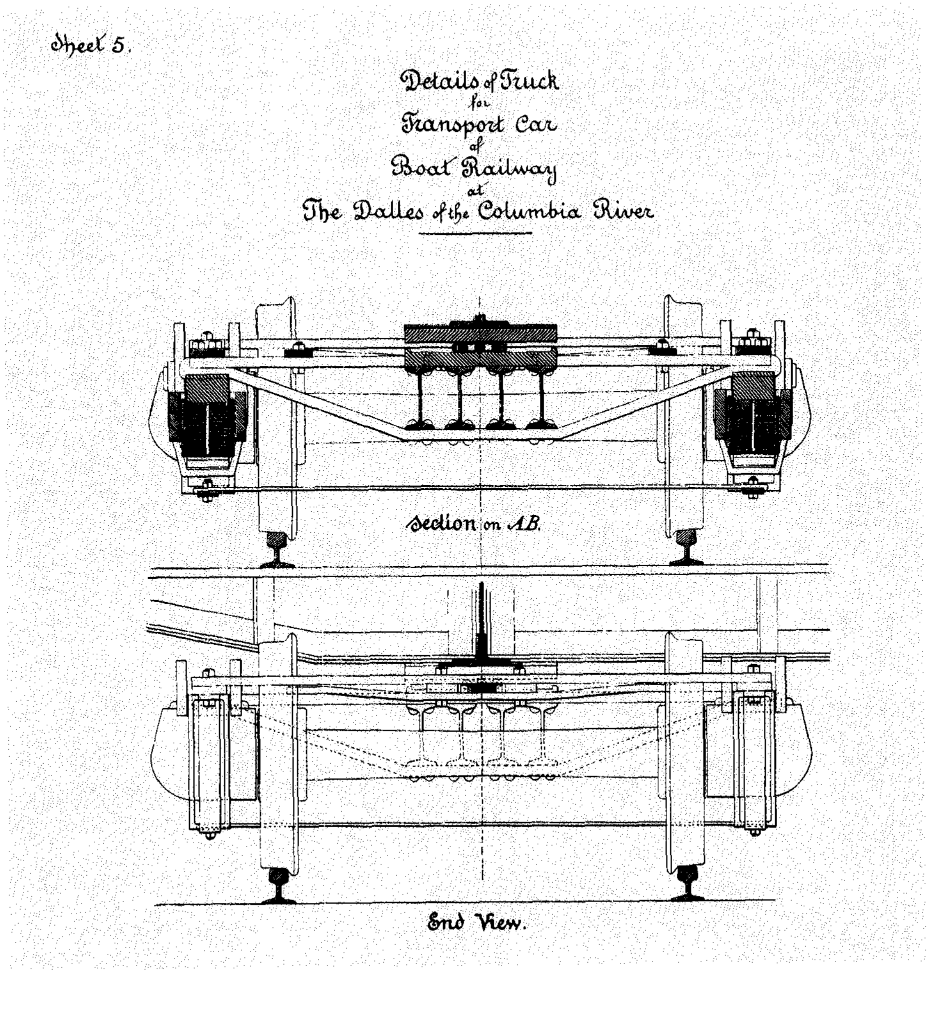
below: 1892 map showing the major wheat growing areas of the Upper Columbia River.

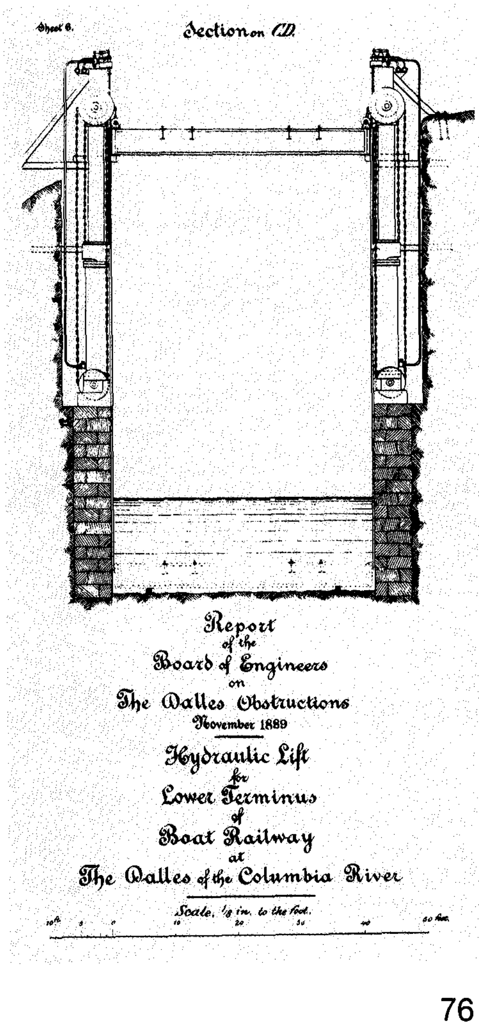
the locks. The engineers designed the same culvert system for use in filling the tandem locks and the Five Mile lock, while the Celilo and Ten Mile locks filled and emptied through butterfly valves in the lock gates. Open river improvements were to be made from the foot of The Dalles Falls (Five Mile Rapids) for 3.5 miles past Three Mile Rapids. Cost of the project was estimated at $4,125,000. The plan was approved, funds appropriated, and initial work authorized in 1904 and 1905. Actual construction on the canal began in October 1905. The state of Oregon also built and operated a portage railroad between The Dalles and Celilo while the Canal was under construction.[45]

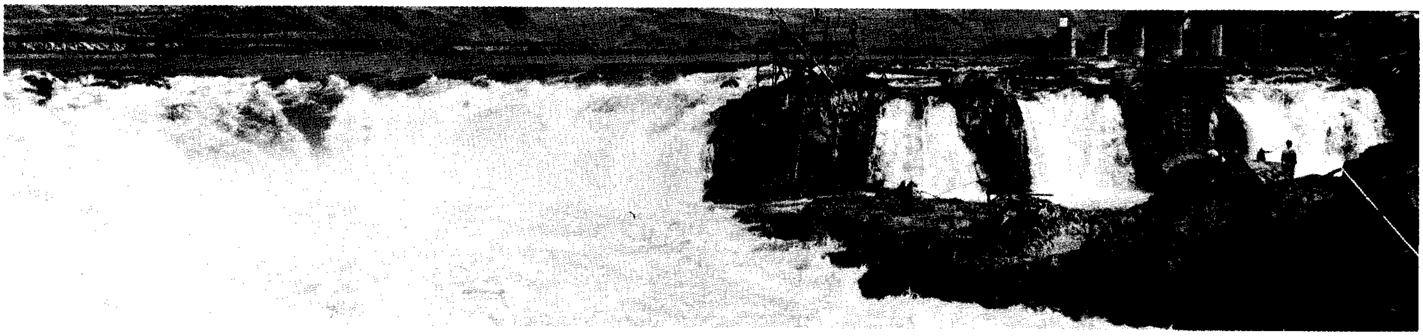
Though The Dalles-Celilo project was twice the length of the Cascades Canal, the two projects resembled each other. Apparently some lessons had been learned in the earlier canal

below: Drawings for the proposed boat lift railway system to bypass The Dalles Rapid.







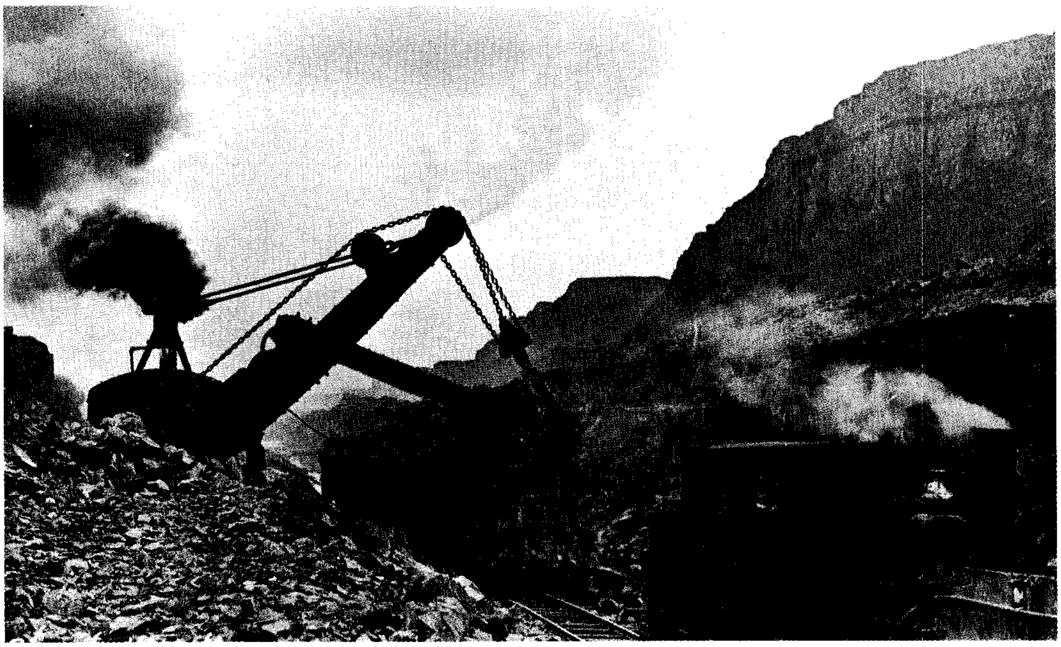


above: The Dalles Rapid.

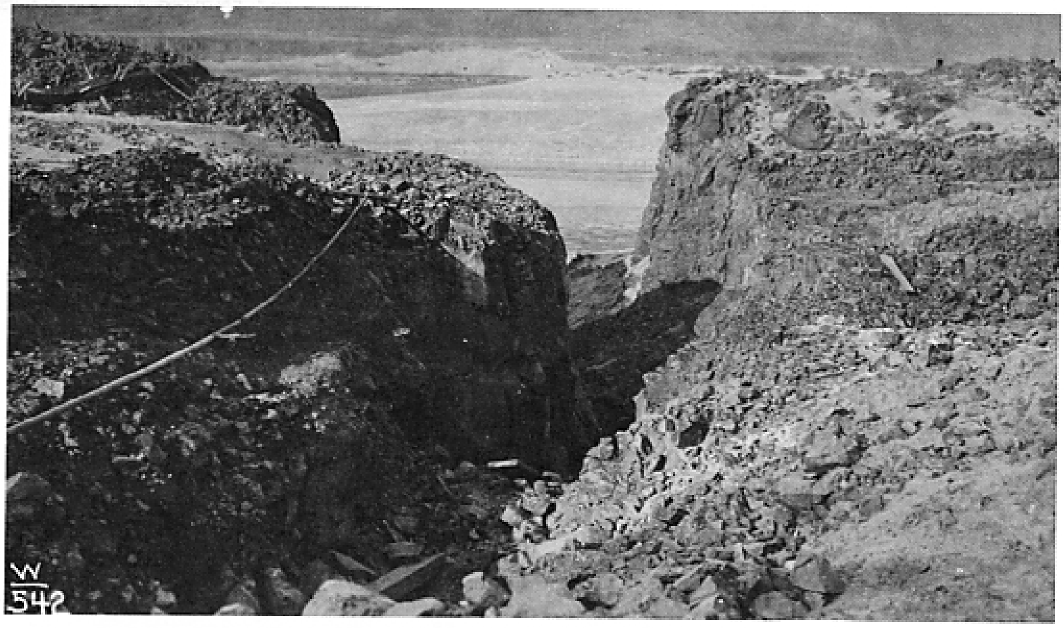
construction. As in the case of the Cascades Canal, the engineer in charge initially complained of delays caused by inefficient contractors and found it necessary to institute several work changes in 1905 and 1908. Lack of funds slowed the work in 1911. But in spite of these problems, The Dalles project—as modified to include a fifth lock, enlargement of all the locks, directional realignment of the canal line, and open river improvements—required about half the time of the earlier one to complete. After 1910, hired labor under a resident engineer performed the excavation, blasting, and concrete work which preceded the construction of the locks. The last work on the project was completed in April 1915. On opening day, 5 May 1915, a procession of six steamboats passed through the canal and a crowd of 6,000 people listened to stirring speeches predicting a new era of increased water traffic at reduced freight rates on the upper Columbia.[46]

The optimistic forecast of traffic above Celilo, however, did not materialize for another 25 years. Great quantities of wheat were grown; but until the era of huge locks and slackwater pools provided by the multi-purpose dams on the middle Columbia and until huge barges plied the river, most of the wheat continued to go by rail. The canal kept railroad rates below monopoly levels, and there was never a chronic shortage of rolling stock as in earlier times. Yet through the 1920s, virtually no commerical traffic passed through the canal; and, except for a spurt in 1933 and 1934 of about 20,000 tons, traffic remained very light until the late 1930s. In 1938 shipping picked up, rising to 139,542 tons in 1939. This developed in response to the completion of the lock at Bonneville Dam in

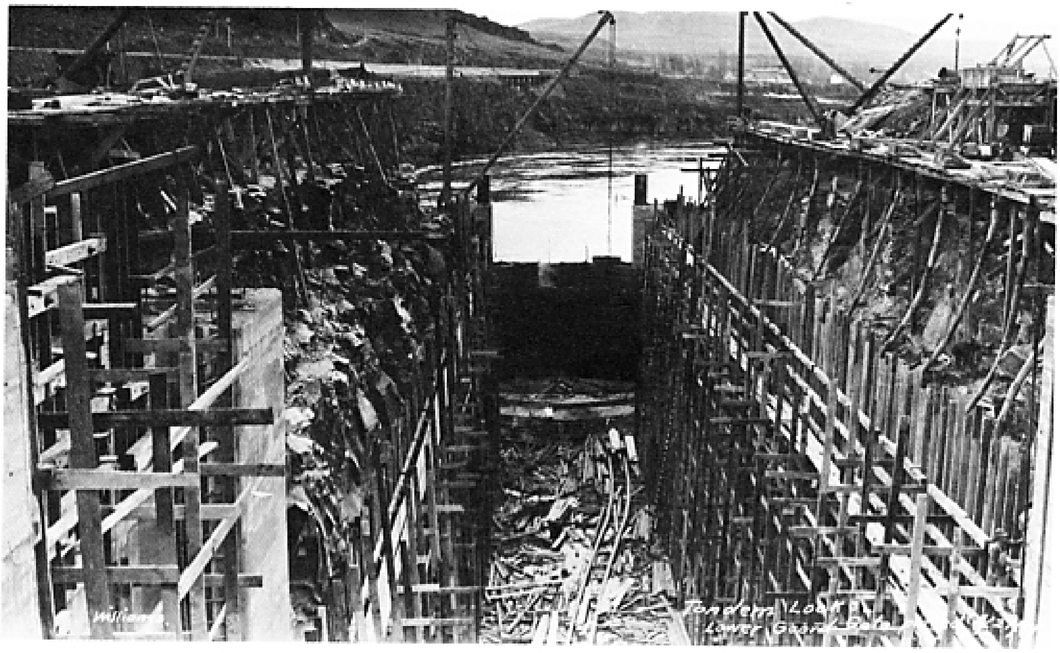
Early surveyors for The Dalles - Celilo Canal.



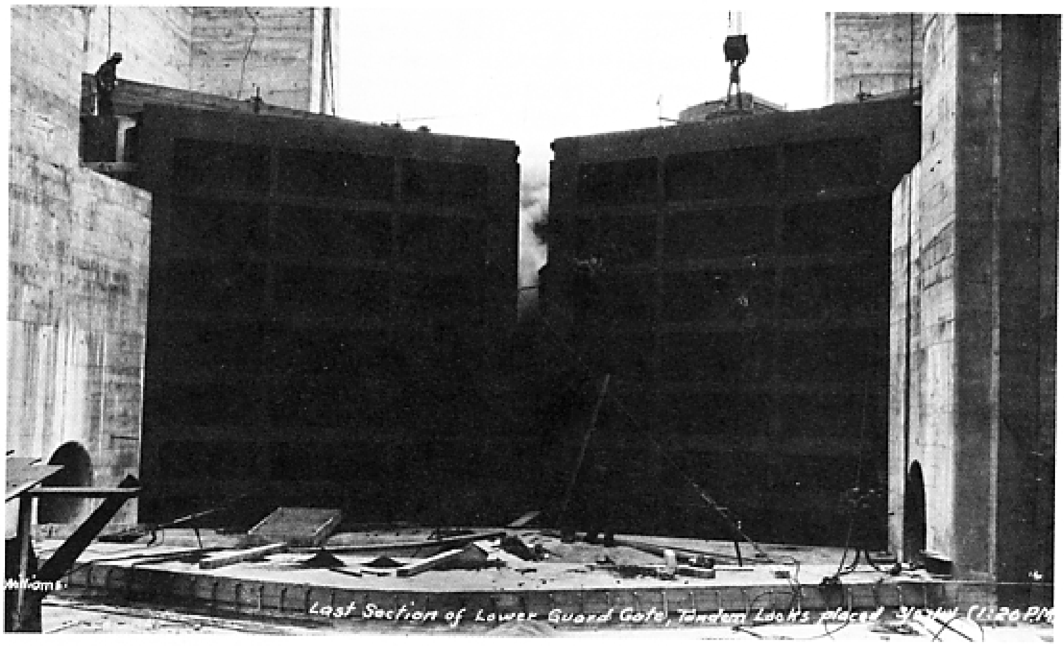
Early equipment excavating bedrock to form The Dalles - Celilo Canal.



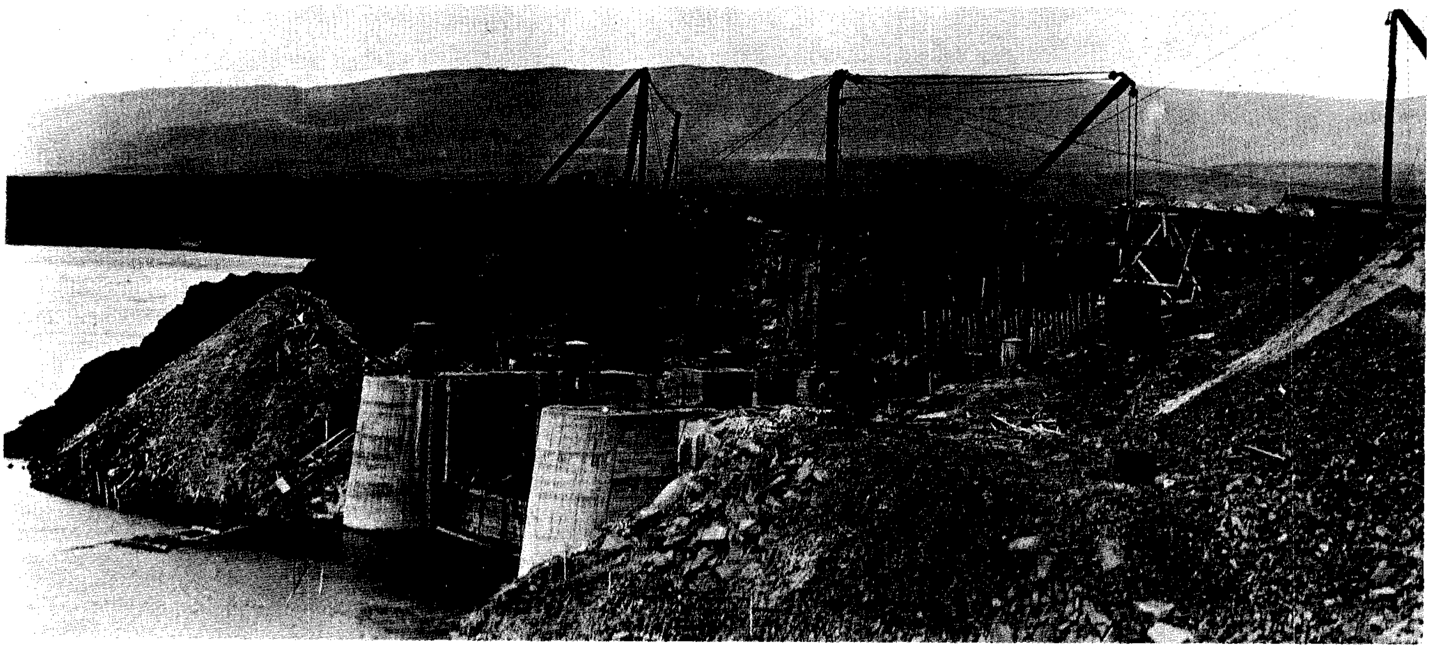
The canal passage established



Work on the canal walls

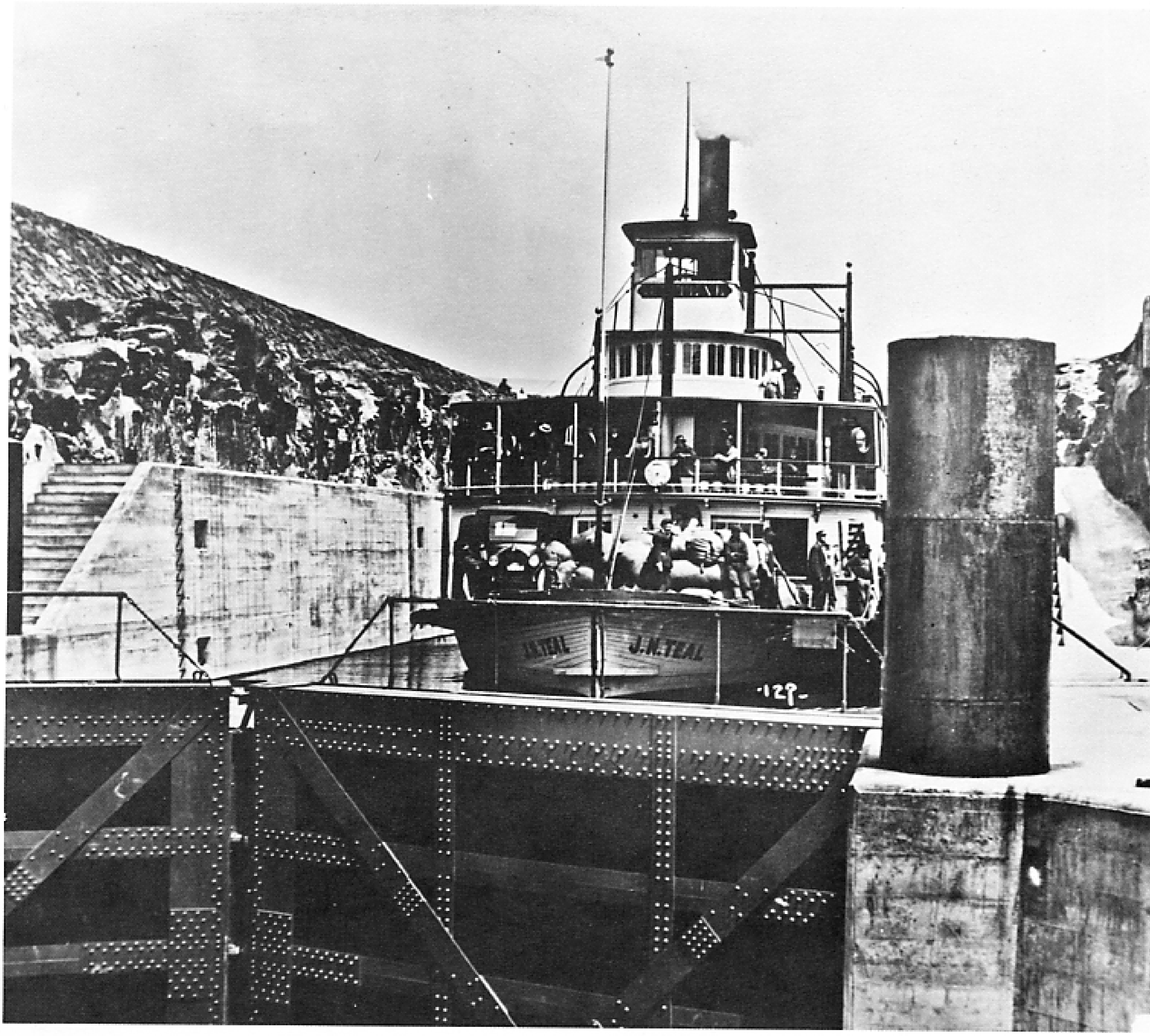


The last section of the canal's lower guard gate was placed on March 27, 1914.



above: The Dalles - Celilo Canal near completion right: The festive dedication of the new canal

January in 1938. Traffic increased steadily through the 1940s until in 1956 over one million tons passed through the canal. Two-thirds of this traffic, however, was not wheat, but petroleum products. After 1956, river traffic passed through the 86-foot lock of The Dalles Dam. The pool of The Dalles Dam inundated The Dalles-Celilo Canal on 9 March 1957, ending its 40 year history.[47]



above: Very little river traffic used The Dalles -Celilo Canal before the late 1930s.